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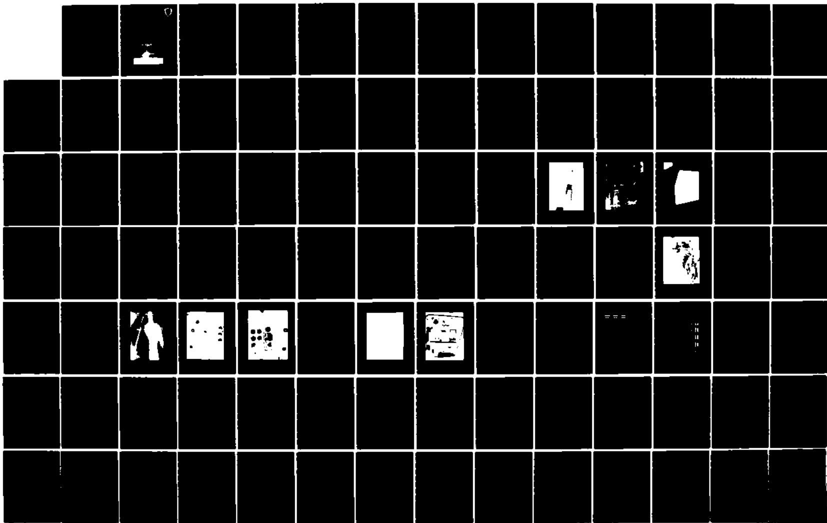

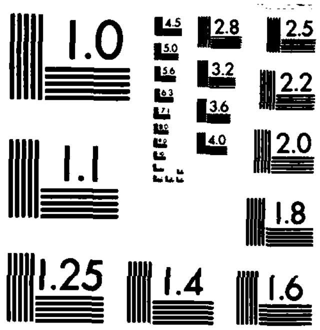
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USAAEFA PROJECT NO. 83-15

AD-A155 394

PRELIMINARY AIRWORTHINESS EVALUATION OF THE OH - 58C WITH 3 - AXIS STABILITY CONTROL AUGMENTATION SYSTEM AND IMPROVED TAIL ROTOR SYSTEM

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OCTOBER 1983

FINAL REPORT

USAAEFA

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

UNITED STATES ARMY AVIATION ENGINEERING FLIGHT ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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Handling Qualities	Preliminary Airworthiness Evaluation
Improved Tail Rotor	Standard Tail Rotor

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The United States Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation on an OH-58C helicopter configured with a 3-axis digital stability control augmentation system (SCAS) and an improved tail rotor during the period 20 June through 11 September 1983. Additional testing on the standard OH-58C equipped with the 3-axis SCAS was required in response to questions which surfaced during working sessions of the Joint Special Study Group investigating OH-58 loss of tail rotor effectiveness. Testing was accomp-

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lished at Arlington, ~~Texas~~ (elevation 630 feet), Leadville, ~~Colorado (elevation~~ 9927 feet) and Alamosa, ~~Colorado (elevation~~ 7535 feet). Test time totaled 44.2 productive flight test hours. With the improved tail rotor, adequate directional control margins were available for flight at all azimuths out to the wind limits (35 KTAS sideward and 30 KTAS rearward) of the aircraft at density altitudes up through 11,000 feet for a gross weight of 3,040 lb. The overall handling qualities of the OH-58C helicopter equipped with a 3-axis digital SCAS in either tail rotor configuration were significantly improved over the unaugmented aircraft configuration except as stated ~~below~~. The combination of the SCAS and improved tail rotor reduced the standard aircraft characteristic uncommanded pitch, roll and yaw attitude oscillations in left sideward flight from an unacceptable to an annoying level. The combination of the SCAS and standard tail rotor reduced the standard aircraft uncommanded pitch, roll and yaw attitude oscillations, in left sideward flight, but they were still excessive. Two handling quality deficiencies were noted: 1) The improved but still excessive pitch, roll and yaw attitude oscillations in left sideward flight of the OH-58C equipped with a 3-axis SCAS and standard tail rotor. 2) The excessive pitch, roll and yaw attitude oscillations in left sideward flight of the OH-58C equipped only with an improved tail rotor (no SCAS). Seven shortcomings were identified. The two most significant shortcomings are: 1) The excessive aircraft vibration levels at airspeeds greater than 90 knots calibrated airspeed and power settings greater than 270 shaft horsepower. 2) The annoying pitch, roll and yaw attitude oscillations observed in left sideward flight at speeds in excess of 15 KTAS with the 3-axis SCAS and improved tail rotor installed.

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DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION SYSTEMS COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120 -1798

REPLY TO
ATTENTION OF

AMSAV-E

SUBJECT: Directorate for Engineering Position on the Preliminary Airworthiness Evaluation of the OH-58C with 3-Axis Stability Control Augumentation System and Improved Tail Rotor System, USAAEFA Project Number 83-15

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1. The purpose of this letter is to establish the Directorate for Engineering position on the subject report. The objective of the Preliminary Airworthiness Evaluation (PAE) was to determine the handling qualities characteristics of an OH-58C with a 3-Axis Stability Control Augumentation System (SCAS) and an improved tail rotor system installed. The PAE was initiated to evaluate potential corrections to the of OH-58C series helicopter loss of tail rotor effectiveness experienced by operational units. Basically, the subject report substantiates that the overall handling qualities of the OH-58C equipped with a 3-axis digital SCAS were improved. It should also be noted that the overall handling qualities of the OH-58C with the 3-axis SCAS and standard tail rotor were improved. The combination of the SCAS and the improved tail rotor installed in the OH-58C resulted in significantly improved handling qualities characteristics as compared to the standard configuration and effectively eliminated previously identified deficiencies.

2. This Directorate agrees with the report Conclusions and Recommendations, except as indicated below. Also, additional comments are provided and are applicable to the report paragraphs as indicated.

a. Paragraph 48a. While excessive pitch, roll and yaw attitude oscillations are reported as a deficiency with the 3-axis SCAS only and standard tail rotor, the pilot workload was reduced.

b. Paragraph 48b. The excessive pitch, roll and yaw attitude oscillations in left sideward flight with the improved tail rotor and SCAS off were reported as a deficiency. We disagree with this conclusion since SCAS off flight is a degraded mode.

c. Paragraph 49a. The excessive vibration levels at airspeeds greater than 90 KCAS with power settings greater than 270 SHP is a correct observation. However, it is not considered a shortcoming since a non-standard uprated transmission was used and the contractor recommended not to exceed the airspeed and power conditions for this prototype OH-58C configuration. Incorporation of the uprated transmission would result in restricting the airspeed and power in the Operator's Manual to below 90 KCAS and 270 SHP respectively.

d. Paragraph 49b. The annoying attitude oscillations are considered a shortcoming, however, this condition occurs when the SCAS is saturated. Otherwise, the condition is satisfactory.

e. Paragraph 49d. The degraded short term rate damping characteristics during steady turns is considered a shortcoming, however, the condition occurs when the SCAS is saturated. Otherwise, the condition is satisfactory.

f. Paragraph 49g. The lack of a directional control force gradient is not considered to be a shortcoming since there was no specification requirement for it in the standard OH-58C. This should be a suggested improvement.

g. Paragraph 50a and 50b. Since there was no specification compliance requirements for the specific noncompliance items listed, they should be disregarded. The PAE was conducted using specification MIL-H-8501A as a guide only and not as a requirement.

h. Paragraph 51. The purpose of the PAE was to evaluate the OH-58C handling qualities characteristics with the 3-axis SCAS and with and without the improved tail rotor. As indicated in the report, the incorporation of the SCAS and improved tail rotor together eliminated the excessive attitude oscillations. Consequently, the recommendations to correct the deficiencies are inconsistent with the test results. The recommendations should be to incorporate the 3-axis SCAS and improved tail rotor to eliminate the basic OH-58C deficiencies.

3. The PAE substantiated that the combination of the 3-axis SCAS and improved tail rotor system significantly improved the OH-58C handling qualities overall and eliminated the deficient excessive pitch, roll and yaw oscillations exhibited in left sideward flight. A Product Improvement Program (PIP) was initiated and Engineering Change Proposals (ECPs) OH-58-252 and OH-58-256 were submitted to the US Army by Bell Helicopter Textron, Inc. (BHTI) which provide for the retrofit of the OH-58C with the 3-axis SCAS and the improved tail rotor.

FOR THE COMMANDER:

Ronald E. Gormont

RONALD E. GORMONT
Acting Director of Engineering

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APPENDIXES

INTRODUCTION

BACKGROUND

1. During the type classification In-Progress Review (IPR) for the OH-58C, the deficiencies of the OH-58C were reiterated. One recommendation of the IPR was to qualify an improved tail rotor and stability augmentation system on the OH-58C to correct previously identified problems. Such a program was established in September 1981. Contractor test efforts progressed to the point that a Preliminary Airworthiness Evaluation (PAE) was scheduled. The US Army Aviation Research and Development Command (AVRADCOM) tasked the US Army Aviation Engineering Flight Activity (USAAEFA) to conduct this PAE (app A, ref 1). The USAAEFA forwarded a test plan to AVRADCOM on 10 June 1983 (ref 2). This test plan was approved on 16 June 1983 (ref 3). The tests were conducted between 20 June and 22 July 1983 and briefed to AVRADCOM on 25 August 1983. The test results briefed, prompted a request from the OH-58 loss of tail rotor effectiveness joint US Army Training and Doctrine Command/Development and Readiness Command Special Study Group to ask for additional follow-on testing. USAAEFA was further tasked by AVRADCOM (ref 4) to conduct additional flight tests and the supplemental test plan (ref 5) was forwarded to AVRADCOM on 16 August and approved (ref 6) on 31 August 1983.

TEST OBJECTIVES

2. The combined objectives of the tests were: a. Conduct testing to determine handling qualities characteristics of an OH-58C with a 3-Axis Stability and Control Augmentation System with and without the Improved Tail Rotor System.

b. Measure out-of-ground effect (OGE) hover power required with both standard and improved tail rotors.

c. Evaluate transient tail rotor power with both tail rotors utilizing T63-A-720 power available and by adjusting the fuel control to limit power to that available from the T63-A-700.

d. Evaluate low speed flight characteristics with the standard tail rotor and the SCAS both operative and inoperative.

DESCRIPTION

3. The OH-58C helicopter is a modification of the OH-58A built by Bell Helicopter Textron (BHT), Fort Worth, Texas. The OH-58C has a single two-bladed, semi-rigid, teetering-type main rotor

and a single two-bladed, delta-hinged, semi-rigid, teetering-type tail rotor. The design gross weight (maximum gross weight) of the helicopter is 3200 pounds. The aircraft is powered by an Allison T63-A-720 engine with an uninstalled intermediate rating (30 minute) of 420 shaft horsepower (shp) at standard sea level conditions. The test aircraft, serial number 68-16850, was configured with a main rotor transmission rated at 335 shp continuous, which was an increase from the standard OH-58C transmission rated at 317 shp for five minutes and 270 shp continuous. This aircraft was also configured with hydromechanically-boosted flight controls in all three axes (OH-58C standard configuration does not have boosted directional control). The tail rotor drive shafting aft of the oil cooler fan drive shaft was replaced with BHT model 206L-3 components to include the tail rotor gearbox. The improved tail rotor drive system was rated at 81 shp continuous and 130 shp transient. Portions of these tests were flown with an improved 65 inch diameter tail rotor and other portions were flown with the standard 62 inch diameter tail rotor. All tests were flown with a main rotor tip cap modification which removed the last 1 1/2 inch from the tip cap to accommodate the larger diameter tail rotor. A three-axis digital Stability and Control Augmentation System (SCAS) was installed. A detailed description of the OH-58C is contained in the operator's manual (app A, ref 7) and modifications to the standard aircraft are discussed in appendix B.

TEST SCOPE

4. The USAAEFA evaluation was conducted in two parts. The first part primarily evaluated the 3-axis SCAS and improved tail rotor during the period 20 June to 22 July 1983. This portion consisted of 32 flights and 20.1 productive flight test hours at the Arlington, Texas test site (elevation 630 feet) and 36 flights and 17.5 productive flight test hours at the Leadville, Colorado high altitude test site (elevation 9927 feet). The additional follow-on testing, which was requested by the OH-58 loss of tail rotor effectiveness Joint Special Study Group, primarily evaluated the handling qualities of the aircraft equipped with the standard tail rotor and 3-axis SCAS and determined the difference in power required between the standard and improved tail rotor installations. This portion was conducted between 1 September and 11 September 1983. During this time period, 4 flights and 1.2 productive test hours were flown at the Arlington, Texas test site and 17 flights and 5.4 productive flight test hours were flown at the Alamosa, Colorado test site (elevation 7535 feet). BHT provided and maintained the aircraft and test instrumentation, and processed the test data. Many combinations

of yaw SCAS gains were flown, but only data for the final configuration are presented in this report. Testing was accomplished within the constraints of the operator's manual and the airworthiness releases (refs 8 and 9, app A). Handling qualities were evaluated using MIL-H-8501 A (ref 10, app A) as a guide. Test conditions are presented in table 1.

TEST METHODOLOGY

5. Flight test data were recorded on magnetic tape by an on-board BHT instrumentation package (app C). Established flight test techniques were used (ref 11 and 12). The test methods and data analysis are briefly discussed in appendix D. A Handling Qualities Rating Scale (HQRS) (fig. 1, app D) was used to augment pilot comments relative to handling qualities. A Vibration Rating Scale (VRS) (fig. 2, app D) was used to augment pilot comments relative to vibrations. Pilot comments were recorded on cockpit data cards and a cockpit voice recorder.

Table 1. Test Conditions[1]

Test	Average Gross Weight (lb)	Average Longitudinal CG (in.)	Average Density Altitude (ft)	Trim Airspeed (KCAS)	Remarks
Hover Performance	3270 to 2630	109.2 (MID)	8380	0	Standard tail rotor
	3230 to 2650	109.1 (MID)	8850	0	Improved tail rotor
Control Positions in Trimmed Foward Flight and Vibrations	3270	107.4 (FWD)	5100	35 - 105	Level Flight
	3020	111.8 (AFT)	5400	34 - 107	
	3170	111.2 (AFT)	5200	42 - 108	Max Power Climb
Static Lateral-Directional Stability	2970	111.8 (AFT)	5740	40, 60, 90	Level Flight
			7230	60, 90	Climbs
			8000	60	Autorotation
Maneuvering Stability	2960	111.8 (AFT)	5000	90	Left and Right Steady Turns, Symmetrical pull-ups and Pushovers
Dynamic Stability	3220	107.5 (FWD)	2160	0	Hover — Control Pulses Doublets and Releases from SHSS[2]
	2920	111.8 (AFT)	2550	60	Climb
	2960	111.8 (AFT)	5070	90	Level
Controllability	2980	111.8 (AFT)	1850	0	Hover — Control inputs in 3 axis
	2960	111.8 (AFT)	5000	90	Level — Control inputs in pitch and roll
	3020	111.8 (AFT)	1600	0	Hover — Yaw only
	3000	106.6 (FWD)	10,000	0	Hover — Yaw only. 10 ft skid height
	3150	107.1 (FWD)	2020	0	Hover — Yaw only. Standard tail rotor
	3040	107.4 (FWD)	9220	0	Hover — Yaw only. Standard tail rotor
Left Directional Controllability in Right Sideward Flight	3010	111.0 (AFT)	8700	0	Standard tail rotor
	3020	110.4 (AFT)	4030	0	Improved tail rotor
Simulated Engine Failures (SCAS on and off)	2980	111.8 (AFT)	4200	60, 90	Max power climb
	2950	111.8 (AFT)	4200	118	Dive to V_{NE} at maximum torque
Simulated SCAS Failures	2490	111.8 (AFT)	1200	0	Hover — Failures induced from trim and with SCAS actuators saturated
	2480	111.8 (AFT)	5300	60, 90	Level
	2470	111.8 (AFT)	4800	118	Dive
Low Speed Flight	3220	107.3 (FWD)	1910	0-35 (0-40 Forward and Right)	Improved tail rotor, 10 ft skid height, SCAS ON. Azimuths of 0°, 90°, 105°, 120°, 150°, 180°, 210°, 225° 240°, 270°.
	3010	106.1 (FWD)	10,800		Improved tail rotor 10 ft skid height, SCAS ON. Azimuths of 0°, 90°, 105°, 120°, 150°, 180°, 210°, 225°, 240°, 270°.
	3010	106.5 (FWD)	1,020		Improved tail rotor SCAS ON/OFF workload comparison flown at azimuths of 0°, 90°, 105°, 225°, 270°.
	3040	107.4 (FWD)	4740		Improved tail rotor SCAS ON/OFF Comparison flown at azimuths of 90°, 270°.
	3200	107.2 (FWD)	1840	0-35	Standard tail rotor SCAS ON/OFF workload comparison flown at azimuths of 90°, 180°, 225°, 270°
	3050	107.3 (FWD)	8900		Standard tail rotor SCAS ON/OFF workload comparison flown at azimuths of 90°, 180°, 225°, 270°.

NOTES:

[1]Testing accomplished at a rotor speed of 354 rpm and in the improved tail rotor configuration except as otherwise noted.
[2]Steady heading sideslip

RESULTS AND DISCUSSION

GENERAL

6. Limited hover performance and handling qualities tests were conducted on the OH-58C helicopter equipped with a 3-axis digital SCAS, standard tail rotor and/or improved tail rotor. These tests were conducted in two phases at Arlington, Texas (elevation 630 feet), Leadville, Colorado (elevation 9927 feet) and at Alamosa, Colorado (elevation 7535 feet). At the conditions tested, the hover performance results indicate that an additional 4 engine shaft horsepower (shp) at light gross weight (2600 lb) and 3 engine shp at high gross weight (3200 lb) were required for the improved tail rotor configuration as compared to the smaller standard tail rotor configuration. With the improved tail rotor, adequate directional control margins were available for sideward and rearward flight out to the wind limits (35 KTAS sideward and 30 KTAS rearward) of the aircraft, at density altitudes up through 11,000 feet for a gross weight of 3,040 lb. The overall handling qualities of the OH-58C helicopter equipped with a 3-axis digital SCAS in either tail rotor configuration were significantly improved over the unaugmented aircraft configuration. The combination of the SCAS and improved tail rotor reduced the standard aircraft characteristic uncommanded pitch, roll and yaw attitude oscillations in left sideward flight from an unacceptable to an annoying magnitude. The combination of the SCAS and standard tail rotor reduced the standard aircraft characteristic uncommanded pitch, roll and yaw attitude oscillations, in left sideward flight, but were still excessive. Two handling quality deficiencies were noted: 1) The excessive pitch, roll and yaw attitude (±5 degree) oscillations in left sideward flight with a 3-axis SCAS and standard tail rotor. 2) The excessive pitch, roll and yaw attitude (±8 degree) oscillations in left sideward flight with only an improved tail rotor (no SCAS). Seven shortcomings were identified. The two most significant shortcomings are: 1) The excessive aircraft vibration levels at airspeeds greater than 90 knots calibrated airspeed (KCAS) and power settings greater than 270 shaft horsepower. 2) The annoying pitch, roll and yaw attitude (±3 degrees) oscillations observed in left sideward flight with the 3-axis SCAS and improved tail rotor.

PERFORMANCE

Hover Performance

7. Limited out-of-ground effect (OGE) hover performance data were obtained for the OH-58C helicopter with the standard and improved tail rotors. The tests were conducted at Alamosa, Colorado using the free flight hover technique. Test results

are presented in nondimensional, dimensional and referred formats because of the different tail and main rotor diameters. Test results are presented in figures 1 through 4, appendix E.

8. Figure 2 presents the total OGE hover power required versus gross weight of the OH-58C with the standard and improved tail rotor. At the lower gross weight (2600 pounds), with less total power required (approximately 4 shp at the conditions tested) the standard tail rotor installed than with the improved tail rotor installed. However, as gross weight was increased, the difference in power required between the two tail rotors decreased and at a gross weight of 3200 pounds the difference was approximately 3 shp. The difference in extra engine horsepower required to hover with the improved tail rotor appears to be largely due to the difference of the tail rotor power required between the standard and improved tail rotors shown in figure 3.

9. Test results obtained from Final Report, USAAEFA Project Number 76-11-2, Airworthiness and Flight Characteristics Evaluation of the OH-58C (ref 13, app A), are also shown in figure 2. Comparing the engine horsepower required results of the previous OH-58C with the current test results of the standard tail rotor, indicates little difference in the power required to hover. In the current configuration, hover power is slightly increased. When considering the different test aircraft involved and the range of data obtained, the difference is within the data scatter. This indicates that the modified main rotor tip cap (para 7, app B) has negligible effect on hover performance.

Tail Rotor Performance

10. Figure 3 also presents the tail rotor characteristics with increasing tail rotor thrust. Tail rotor thrust was computed from main rotor torque with the assumptions stated in paragraph 8, appendix D. For a given tail rotor thrust, the improved tail rotor requires less pedal (0.6 inch) which equates to less tail rotor blade angle (approximately 2.0 degrees). The tail rotor power increases with the improved tail rotor is reflected in the overall increase in power required to hover (para 8). Figure 4 shows the referred tail rotor thrust power characteristics.

11. Comparing the standard tail rotor with the improved tail rotor during OGE hover shows that the improved tail rotor requires more horsepower (approximately four referred shp more at low gross weight and one more at high gross weight). However, significant improvement in left directional pedal margins were observed with the improved tail rotor (the pedal requirement decreases by 0.6 inch and the tail rotor blade angle decreases by 2.0 degrees).

HANDLING QUALITIES

Control System Characteristics

12. The flight control system characteristics were evaluated with rotors stationary, SCAS ON, and electrical and hydraulic power applied to the helicopter. Control forces were measured using a hand-held force gauge and were qualitatively verified in flight. The flight control system characteristics measured with no adjustable friction applied are presented in figures 5 through 8, appendix E. Typical flight control system characteristics with friction adjusted to a comfortable level are shown in figures 9 through 11. The lateral and longitudinal cyclic control system characteristics were essentially unchanged from the standard OH-58C helicopter (ref 13, app A). The large trim control displacement bands were similar to those of the standard OH-58C and remain a shortcoming. The directional control system characteristics were significantly changed from the standard OH-58C due to the installation of a hydraulic boost actuator required for the three-axis SCAS. No force gradient or trim system was incorporated in the directional controls. The control system characteristics were satisfactory except for the lack of a directional control force gradient, which is a shortcoming. The lack of a force gradient system in the directional controls did not provide positive self-centering and failed to meet the requirements of paragraph 3.3.10 of MIL-H-8501A.

Control Positions in Trimmed Forward Flight

13. The control positions in trimmed level forward flight were evaluated at the conditions listed in table 1. The test results are presented in figures 12 and 13, appendix E. The variation of longitudinal control position was in the conventional direction in that increasing forward control was required to trim at increased airspeed. The variation of longitudinal control position with airspeed at an aft center of gravity (cg) (fig. 13) was essentially zero from 34 to 40 KCAS but no adverse handling qualities were attributable to this characteristic. The lateral and directional control displacements required with increasing airspeed were minimal and control margins at all conditions tested were adequate. The level flight control positions in trimmed forward flight of the OH-58C with SCAS ON and improved tail rotor were similar to the standard helicopter and are satisfactory.

14. The control positions in trimmed climbing flight were evaluated at the conditions listed in table 1. Maximum continuous power (335 shp) was used at each airspeed. Test results are presented in figure 14, appendix E. Longitudinal control position

variation with airspeed was always conventional, and other control position displacements required were minimal with adequate control margins at all conditions tested. The climbing flight control position characteristics of the OH-58C with SCAS, improved tail rotor, and higher shp were similar to the standard helicopter and are satisfactory.

15. Trimmability characteristics were evaluated concurrently with the control position tests. Longitudinal and lateral trim characteristics were unchanged from the OH-58C standard configuration. A time history of a directional trim task is presented in figure 15, appendix E. Initially during this task, the trim ball was one ball width out to the left of trim, the ball was placed back in the center of the race and the controls held fixed. During the next 25 seconds, the yaw SCAS washout circuit slowly returned the directional actuator to the center (null) position placing the aircraft one-half ball width out of trim. This procedure was repeated several times to restore the aircraft to an acceptable directional trim condition. The annoying yaw trimmability characteristic was particularly noticeable when making power changes and the yaw SCAS actuator attempted to reduce the yaw rate imposed by the power change. The multiple directional control inputs required to establish directional trim is a shortcoming.

Static Lateral-Directional Stability

16. The static lateral-directional stability characteristics of the OH-58C configured with a 3-axis digital SCAS and improved tail rotor were evaluated at the test conditions shown in table 1. Test results are presented in figures 16 through 21. The directional stability and sideforce characteristics were positive for all conditions tested. Positive dihedral effect was noted for all conditions tested except during 60 KCAS autorotational flight, where neutral dihedral effect was observed. The neutral dihedral effect observed during 60 KCAS autorotational flight was not noted qualitatively. The static-lateral directional stability characteristics of the OH-58C configured with a 3-axis digital SCAS and improved tail rotor were satisfactory.

Maneuvering Stability

17. The SCAS ON maneuvering stability characteristics of the OH-58C configured with the improved tail rotor were evaluated in left and right steady turns, and in symmetrical pull-ups, and push-overs at the test conditions listed in table 1. Maneuvering

stability data is presented in figure 22, appendix E. Maneuvering stability as indicated by the variation of longitudinal control position with cg normal acceleration determined during pull-up and pushover maneuvers was positive and qualitatively similar to the standard (non-SCAS) aircraft. During steady turns, large aft longitudinal stick excursions (as much as 2 inches) were required at bank angles less than 35 degrees. During a rollout from a steady turn, the opposite tendency (forward stick required) was observed. The SCAS continues to counter the nose-up pitch rate in the turn with nose down SCAS actuator motion requiring aft stick application to maintain airspeed until the longitudinal channel of the SCAS saturated. When the longitudinal SCAS was saturated, a degraded short-term response to gusts was noted. The large longitudinal stick excursions required when executing steady turns (and during roll out of steady turns) and the degraded short-term rate damping characteristics observed during steady turns are both shortcomings.

Dynamic Stability

18. The short-term dynamic stability characteristiacs of the OH-58C aircraft with 3-axis digital SCAS and improved tail rotor were evaluated at the test conditions shown in table 1. Gust response characteristics were simulated in all control axes by single axis 1 inch control pulse inputs which were held for 0.5 seconds and by releases from steady heading sideslips. The short-term dynamic stability characteristics observed in all axes were deadbeat. The aircraft was also flown both SCAS OFF and SCAS ON in light turbulence as shown in figures 23 and 24, respectively. Increased short-term rate damping provided by the SCAS reduced the aircraft gust response and significantly reduced pilot workload to maintain steady flight.

19. The longitudinal long-term response was evaluated at the conditions shown in table 1 by trimming the aircraft at the desired airspeed and then increasing or decreasing the airspeed using only the cyclic control. The cyclic control was then returned to the trim position. At all conditions other than high power climbs at low airspeeds, the response was essentially deadbeat with the airspeed stabilizing near the trim airspeed with no overshoots.

20. During high power, low airspeed climbs the standard OH-58C exhibits a divergent long period oscillation in the longitudinal axis similar to the SCAS OFF response of the test aircraft shown in figure 25, appendix E. Figure 26 is a time history of the longitudinal long period oscillation observed SCAS ON. The

response was essentially neutrally damped and is improved over the SCAS OFF characteristics. The longitudinal long-term dynamic stability characteristics of the OH-58C with SCAS ON is satisfactory.

Controllability

21. Controllability characteristics were evaluated by applying incrementally larger step inputs in each control axis while holding all other controls fixed. The aircraft response was then recorded. Controllability was evaluated in all three axes at a hover and in pitch and roll at 90 KCAS. Directional controllability characteristics were measured for both the standard and improved tail rotor configurations SCAS ON with the final yaw SCAS gains for the respective tail rotor. Test conditions are shown in table 1. Data collected during controllability testing are presented in figures 27 through 38, appendix E.

22. The longitudinal controllability characteristics were evaluated at a hover and at 90 KCAS (figs. 27 and 28, app E). The longitudinal controllability characteristics SCAS ON were qualitatively similar to the standard aircraft (no SCAS) except that no dig in (continuously increasing normal load factor with constant longitudinal control position) tendency was observed. A dig-in characteristic was documented on the standard OH-58C (ref 13, app A). Longitudinal control power and response were approximately the same as the no SCAS aircraft. The sensitivity of the longitudinal control was approximately double that of the standard OH-58C but was not objectionable. The longitudinal controllability characteristics of the OH-58C equipped with the 3-axis SCAS and improved tail rotor are significantly improved and are satisfactory.

23. The lateral controllability characteristics were evaluated at a hover and at 90 KCAS (figs. 29 and 30, app E). SCAS ON controllability data compared to standard aircraft data (ref 14, app A) indicates that the SCAS equipped aircraft has a slightly greater control response and sensitivity. These characteristics were not qualitatively perceived during flight. The lateral controllability characteristics of the OH-58C equipped with with 3-axis SCAS and improved tail rotor are satisfactory.

24. Directional controllability (SCAS ON) was evaluated at two altitudes for both tail rotor configurations (figs. 31 through 34, app E). Directional SCAS gains (feedback and feedforward) were varied during these tests to optimize overall aircraft handling qualities. Data presented in appendix E reflects the final yaw SCAS gains for the particular tail rotor configuration.

For all conditions tested, the aircraft responded in the proper direction with higher rates for increased pedal displacements. Qualitatively, the aircraft responded to pedal inputs with similar sensitivity as the standard non-augmented aircraft. The most obvious difference between SCAS ON and OFF was the yaw rate tended to reach a steady value SCAS ON as opposed to yaw rates increasing continuously with SCAS OFF. This is due to the absence of any directional damping in the basic OH-58 which has been continually evaluated as a shortcoming. During typical hover maneuvers (except left crosswind hover), the SCAS did not exhibit a tendency to saturate. The directional controllability characteristics as measured by step inputs (as opposed to mission maneuvering) were satisfactory for the OH-58C helicopter configured with a 3-axis SCAS and improved tail rotor or standard tail rotor.

25. Directional controllability was also evaluated in terms of recovery from steady yaw rates (figs. 35 through 38, app E). These maneuvers were documented only for the improved tail rotor with the final yaw SCAS gains. The aircraft was stabilized in a steady yaw in one direction, then incrementally greater opposite step directional control inputs were introduced with the aid of a control fixture. Moderate (approximately 30 degrees per second) and high (approximately 45 degrees per second) yaw rates were used for trim conditions. In all cases the aircraft yaw rate changed in the proper direction with no hesitation. The directional controllability characteristics in steady yaw rates of the OH-58C equipped with a 3-axis SCAS and improved tail rotor are satisfactory.

26. Left directional controllability in right sideward flight was determined at the conditions shown in table 1. These tests were conducted to evaluate the left yaw rate generation capability of the aircraft with a simulated right hover crosswind (right sideward flight) at various true airspeeds. This maneuver was performed with both the standard and improved tail rotors and the results compared. Initially, the maximum yaw generation capability of the aircraft (SCAS ON) was determined by stabilizing at each true airspeed from hover in 5 knot increments to the highest right sideward flight speed attainable with the standard tail rotor configuration. The tail rotor was then changed to the improved version (utilizing the improved tail rotor drive system for both configurations). Since obtaining exactly the same size directional control input would be unlikely, a test procedure was established to record a left directional control input of lesser size than the standard tail rotor control step and then one of slightly greater size. Interpolation was then used to compare actual aircraft reactions recorded during standard tail rotor configuration step inputs with calculated

improved tail rotor control deflections of equal magnitude. Test data is presented in table 2.

27. Comparing the improved and standard tail rotor data indicates that with similar size directional control displacements, approximately equal yaw rates were generated. However, since the improved tail rotor required less pedal displacement for the same trim condition, there was still approximately 10 percent left directional control margin remaining when the standard tail rotor configuration was on the stop. During these maneuvers, the maximum transient tail rotor power was recorded as well as the steady state tail rotor power increase. In accomplishing essentially the same left yawing maneuver, the transient and steady state tail rotor power increases were smaller for the improved tail rotor than for the standard.

28. An evaluation of the transient power observed with the fuel control adjusted to limit power available to that of the T63-A-700 was not accomplished for two reasons. An adequate explanation of engine performance effects due to fuel control adjustment was not available. Additionally, the power required to perform steady trim conditions in right sideward flight at speeds between approximately 15 KTAS (above effective translational lift) and limit speed (determined by pedal margin) was sufficiently low such that the transient power requirements of the tail rotor were well within the excess power available of the T63-A-700 engine. The aircraft configured with the smaller engine would not have sufficient power to hover (10 foot skid height).

Low Speed Flight Characteristics

29. Low speed flight characterisitcs were evaluated to determine the effects on handling qualities due to the installation of the 3-axis SCAS and/or improved tail rotor. The low speed flight testing was conducted by stabilizing in formation with a ground pace vehicle at a skid height of 10 feet at relative azimuths (measured clockwise from the nose of the aircraft) of 0, 90, 105, 120, 150, 180, 210, 225, 240, and 270 degrees. Low speed flight testing was accomplished SCAS ON and OFF and also with either the standard or improved tail rotor installed at the test conditions shown in table 1. Various yaw SCAS gains (feedback and feedforward) were flown during these tests. Unless otherwise stated, data presented in this report reflects the final yaw SCAS gain configuration. Low speed flight characteristics data are presented in figures 39 through 79, appendix E.

Table 2. Directional Controllability Summary in Right Sideward Flight

Target True Airspeed (kts)	Tail Rotor	Left Pedal Input Size (in)	Left Pedal Margin After Pedal Input (in)	Yaw Rate After 1.5 sec (deg/sec)	Maximum Tail Rotor Power Increase (shp)	Steady State Tail Rotor Power Increase (shp)
0	Standard[1] Improved[2]	1.2 1.2	0 0.6	33 28	53 40	20 13
5	Standard Improved	0.9 0.9	0 0.6	24 25	44 38	21 8
10	Standard Improved	0.75 0.75	0 0.65	23 20	38 29	19 5
15	Standard Improved	0.8 0.8	0 0.6	22 22	39 38	8 9
20	Standard Improved	0.9 0.9	0 0.5	22 23	42 41	18 14
25	Standard Improved	0.8 0.8	0 0.7	19 19	35 36	16 13
30	Standard Improved	0.7 0.7	0 0.65	16 15	29 26	19 9
35	Improved	1.1	0	23	53	27
40	Improved	0.9	0	20	42	20

NOTES:

[1]Test conditions: SCAS ON, average cg FS 111.0, average gross weight 3010 lb, average density altitude 8700 ft, average OAT 13.5° C, average main rotor speed 354 rpm.
[2]Test conditions: SCAS ON, average cg FS 110.0, average gross weight 3020 lb, average density altitude 9030 ft, average OAT 17.0° C, average main rotor speed 354 rpm.

30. The task used to obtain qualitative data on low speed handling characteristics during all these tests was as follows: The pilot attempted to maintain the flight condition within a ±3 degree heading accuracy and a ±2 foot skid height accuracy. The characteristics of low speed flight for this aircraft can be separated into 3 general areas. For the standard aircraft, flight at azimuths from 300 degrees, clockwise to approximately 150 degrees have exhibited reasonably stable flight characteristics in all axes. Overall handling qualities for flight at these azimuths have been reported (ref 13, app A) to be HQRS 3 for the maneuver stated above. Flight at azimuths from approximately 150 through 210 degrees were noted to require large longitudinal stick excursions to control pitch attitude as well as frequent large amplitude directional control motions to maintain heading. Overall handling qualities for these azimuths have been reported to be HQRS 5. Flight at azimuths from approximately 210 degrees clockwise to approximately 300 degrees were noted to require frequent large amplitude control motions to maintain aircraft control due to uncommanded pitch, roll and yaw oscillations. Overall handling qualities in this area were noted to be HQRS 7.

31. During the first part of these tests, the 3-axis SCAS and improved tail rotor systems were evaluated. Flights were conducted both SCAS ON and OFF at the Arlington, Texas test site as well as at the Leadville, Colorado high altitude test site. The larger diameter improved tail rotor clearly exhibited increased directional control margin at all airspeeds and azimuths as compared to the standard tail rotor configuration (ref 13, app A). The smallest directional control margin was in right sideward flight at the high altitude test site (11,000 ft density altitude) (fig. 53, app E) but was still greater than 10 percent left pedal remaining at the crosswind limit of the aircraft (35 KTAS) and was effective in producing left yawing moments at that speed. With the improved tailrotor, adequate directional control margins exist in sideward and rearward flight at all azimuths tested out to the wind limits (35 KTAS sideward and 30 KTAS rearward) of the aircraft.

32. With the improved tail rotor SCAS ON handling qualities ratings in the azimuth area increasing clockwise from 300 to 150 degrees were improved from HQRS 3 (standard aircraft) to HQRS 2 in that little pilot workload was required to maintain maneuver performance within the desired tolerance. The limited SCAS activity and resulting pilot control manipulation to perform flight at the 90 degree azimuth (25 KTAS) is shown in figure 39, appendix E. In the rearward flight region (150 to 210 degrees),

handling qualities ratings were improved from HQRS 5 (standard aircraft) to HQRS 4 in that only moderate pilot compensation was required to perform the maneuver within desired performance criteria. The increased SCAS actuator activity and rate of attitude change is shown in figure 40, appendix E when performing rearward flight as compared to the 90 degree azimuth. In the left sideward flight regime (azimuths from 210 to 300 degrees) the SCAS and tail rotor system combination helped reduce the typical OH-58C ±10 degree yaw attitude excursions to approximately ±3 degrees. Handling qualities ratings were improved from HQRS 7 (standard aircraft) to HQRS 6 in this region. Figure 41, appendix E, presents data at the 225 degree azimuth and 25 KTAS. Very large SCAS actuator inputs as well as pilot control motions were required to perform this maneuver. It is important to note that the pilot was able to maintain the desired performance level even though extensive pilot compensation was required and aircraft control was never in question. The 3-axis SCAS and improved tail rotor system have significantly improved the overall low speed flight characteristics of the OH-58C. The annoying uncommanded pitch, roll and yaw (±3 degree) oscillations observed (when the SCAS becomes saturated) in left sideward flight with the 3-axis SCAS and improved tail rotor (improved from a deficiency for the basic aircraft) are a shortcoming.

33. Certain portions of these tests were conducted SCAS OFF with the improved tail rotor installed (figs. 61 through 65, app E). Qualitative pilot comments indicated that slightly fewer directional control inputs of slightly less magnitude were required with the improved tail rotor as compared to the standard tail rotor installation. The standard aircraft uncommanded pitch, roll and yaw oscillations were still present in left sideward flight although the yaw oscillations were slightly decreased to approximately ±8 degrees. These large amplitude oscillations required the pilot to devote 100 percent attention to maintain aircraft attitude control, particularly when hovering in close quarters. No time would be available for the pilot to accomplish mission tasks such as map reading or even radio channel selection. Although very slightly improved handling qualities were noted with the improved tail rotor as compared to the standard tail rotor, the most noteable improvement was the increased left pedal margin in right sideward flight (para 31). The excessive pitch, roll and yaw attitude (±8 degrees) oscillations in left sideward flight of the OH-58C equipped with an improved tail rotor (SCAS OFF) are a deficiency.

34. Main rotor speed effects on directional control margin with the improved tail rotor were evaluated by stabilizing at incrementally greater true airspeed in right sideward flight first at

354 main rotor rpm and then again at 346 rpm. Data are presented in figures 66 and 67, appendix E. Comparison of these figures indicate that adequate directional control margin was available even at the reduced rpm. Within the scope of the tests, directional control margin was not appreciably effected by varying main rotor speed.

35. Another portion of this evaluation was conducted to determine the low speed flight characteristics of the OH-58C equipped with 3-axis SCAS and standard tail rotor. Since the standard tail rotor directional control margins were known to be limited at high altitude conditions (i.e., Leadville, Colorado test site) a lower test site was selected (Alamosa, Colorado) for the high altitude portion of the evaluation. Yaw SCAS gains were varied during these tests to determine optimum overall handling characteristics and the balance of the test program was flown with these final yaw SCAS gains. Data for this configuration are presented SCAS ON for the Arlington, Texas and Alamosa, Colorado test sites and SCAS OFF for the Alamosa test elevation in figures 68 through 79, appendix E, respectively.

36. Aircraft low speed handling characteristics were similarly improved in this configuration as was noted in the SCAS/improved tail rotor configuration (para 32) for the right sideward and rearward azimuth regimes. In the left sideward flight regime no combination of yaw SCAS feedback and feedforward gains were found which allowed the pilot to accomplish the ±3 degree heading task discussed in para 31. Approximately ±5 degrees was the best yaw attitude control possible with maximum tolerable pilot compensation (HQRS 7). At all azimuths tested, the pilot workload was reduced and maneuver performance criteria were more closely met than in the SCAS OFF configuration. The low speed flight characteristics of the OH-58C helicopter equipped with a 3-axis SCAS and standard tail rotor were improved as compared to the no SCAS configuration particularly in right sideward and rearward flight.

37. The uncommanded yaw oscillations (coupled with pitch and roll) observed in left sideward flight were reduced in magnitude from approximately ±10 degrees SCAS OFF, to approximately ±5 degrees SCAS ON, even with maximum tolerable pilot compensation. Although this improvement noted SCAS ON, did reduce pilot workload, the task (±3 degree yaw attitude control) still could not be performed. Virtually 100 percent of the pilot's attention was directed to aircraft attitude control thus severely limiting any mission task accomplishment. The excessive

pitch, roll and yaw oscillations (±5 degrees) in left sideward flight of the OH-58C helicopter equipped with 3-axis SCAS and standard tail rotor remains a deficiency.

Aircraft System Failures

Simulated Engine Failure:

38. Simulated sudden engine failures (SCAS ON) were evaluated at the test conditions listed in table 1. Time history data gathered for the extreme conditions (maximum allowable power) are presented for 60, 90 and 115 (V_{Ne}) KCAS in figures 80 through 82, appendix E, respectively. Simulated sudden engine failures were accomplished by stabilizing on the test condition and then rapidly closing the throttle to the idle position while maintaining all other controls fixed for approximately two seconds or until recovery was required (as dictated by low rotor speed, excessive rates, attitudes, etc.). A build-up process was used to incrementally increase engine power at each test condition until maximum allowable power was attained. For airspeeds of 90 KCAS and below, 335 shp (uprated main rotor transmission limit) was used. For airspeeds above 90 KCAS, 270 shp was used as maximum continuous. The most notable difference between standard aircraft simulated sudden engine failure and those noted with the 3-axis SCAS and improved tail rotor was the lack of aircraft attitude change cues to identify the loss of engine power. The aircraft low rotor speed light and audio warning indications were adequate pilot cues to identify the malfunction. The SCAS prevents the aircraft normal reaction to the loss of engine power until SCAS actuator saturation, and only about 5 degree yaw attitude excursions (from trim) were noted. The simulated sudden engine failure characteristics of the OH-58C configured with a 3-axis SCAS, improved tail rotor, and uprated main rotor transmission are satisfactory.

39. Simulated sudden engine failures were again evaluated SCAS OFF at the test conditions listed in table 1. Time history data gathered for the extreme conditions (maximum allowable power as defined in last paragraph) are presented in figures 83 through 85, appendix E. Aircraft reactions to simulated sudden engine failures were similar to those noted with the standard aircraft. As much as 14 degree yaw attitude excursions (particularly at low airspeed) were observed during these tests. Autorotational entry required normally expected control applications. Aircraft attitude and rate excursions were not excessive. The simulated sudden engine failure characteristics of the OH-58C (SCAS OFF) equipped with an improved tail rotor and uprated main rotor transmission, while degraded from the SCAS ON case, are satisfactory.

Stability and Control Augmentation System Failures:

40. Simulated SCAS system failures were evaluated at the conditions listed in table 1. SCAS actuator hardovers were introduced into the system using a BHT manufactured SCAS hardover test control unit, P/N 206-078-177-101 with procedures outlined in BHT report No. 206-099-992 dated 14 December 1982. This document was reviewed and approved by AVRADCOM. With this unit, an actuator hardover could be introduced into the SCAS system in any axis, in both directions and scaled from 0 to 100 percent SCAS actuator authority. Failures were introduced both from normal actuator working positions (generally less than 20 percent from null) and from the saturated condition. Power supplies were shut off and circuit breakers were failed from the cockpit to assess aircraft reactions. Time history data obtained from these tests are presented in figures 86 through 95, appendix E.

41. SCAS actuator hardovers introduced from the normal level flight condition (actuator not saturated) resulted in aircraft reactions which were very mild (figs. 86 through 89, app E). Some actuator hardovers were difficult to distinguish due to the small aircraft reactions. Generally only a bump could be felt in the aircraft as the actuator quickly recentered following the hardover. This rapid (approximately 0.2 second) recentering allowed little time for the aircraft to react. Following the failure, the aircraft returned to the SCAS OFF configuration and the pilot was alerted to the degraded SCAS system by a SCAS fail caution light. All SCAS failure modes introduced by interrupting power supplies or failing cockpit circuit breakers resulted in similar mild aircraft reactions. The simulated SCAS failure characteristics from normal actuator positions of the OH-58C helicopter equipped with a 3-axis digital SCAS and improved tail rotor system are satisfactory.

42. The design of the 3-axis digital SCAS tested, allowed long duration saturation of specific SCAS actuators during certain maneuvers. During steady turns the pitch axis of the SCAS saturated both cyclic actuators in the extend direction. Prior to the time required for long term yaw rate washout effectiveness, yaw SCAS actuator saturation was also observed. Due to the frequency of occurrance of SCAS actuator saturation, hardover tests were accomplished from these saturated conditions in both actuator directions. Two failure modes were noted. When a hardover was induced in the opposite direction to the saturation (i.e., retract hardover from an actuator saturated at extend position), the actuator recentering was immediate (figs. 90

through 93, app E). When a hardover was induced in the same direction as the saturation (i.e., extend hardover from an actuator saturated at the extended positon), the recentering event did not take place until the actuator was no longer required to be in the full extend position (figs. 94 and 95, app E). Although the timing between the hardover initiation and the actuator recentering was different, the aircraft reaction was similar. In each case the rapid actuator recentering from the saturated position provided an input into the flight control system which was of greater magnitude and resulted in aircraft reaction more severe than the normal actuator position hardover failures. For cyclic hardovers, a rapid nose up pitch rate of approximately 10 degrees per second was observed requiring pilot reaction to prevent excessive aircraft attitude excursions. These attitude changes were not considered excessive and normal pilot reaction was adequate to effect recovery. It was not possible to maneuver the aircraft in such a manner as to saturate the cyclic SCAS actuators in roll (i.e., one actuator saturated at extend and the other at retract) or to saturate the cyclic SCAS actuators in the retract position for extended periods of time. During yaw SCAS saturated actuator tests, similar failure modes were noted. Again hardover simulations in the opposite to saturation direction resulted in immediate actuator recentering and the aircraft reverted to the basic aircraft. Hardover simulations in the direction of saturation were not observed until the yaw SCAS actuator was no longer required to be at a saturated condition. The saturated SCAS actuator simulated failure characteristics of the OH-58C equipped with a 3-axis SCAS and improved tail rotor are satisfactory.

VIBRATION

43. Vibration characteristics were evaluated during level flight and maximum power (335 shp) climbs at the test conditions shown in table 1. Test data collected for these conditions are presented in figures 96 through 101, appendix E. In both level flight and maximum power climb, the pilot's and copilot's seat vertical two-per-revolution vibration levels were higher than the military specification limit (ref 10, app A) of 0.15 g for airspeeds of approximately 95 KCAS and above. Qualitatively the aircraft vibration levels were VRS 6 (fig. 2, app D) or below for airspeeds below or equal to 90 KCAS and VRS 7 through VRS 9 with increasing airspeed above 90 KCAS for these stabilized test conditions. The high vibration levels resulting from the combination of high power settings (greater than 270 shp) and high airspeeds (greater than 90 KCAS) led the contractor to recommend that a 90 knots indicated airspeed (KIAS) limit be placed on utilization of the additional power (from 270 shp continuous to 335 shp continuous) provided

by the uprated main rotor transmission. The aircraft vibration levels of the OH-58C aircraft equipped with the uprated main rotor transmission (335 shp continuous) are excessive at airspeeds greater than 90 KCAS and power settings greater than 270 shp and are a shortcoming. The excessive vertical vibration levels at the 2 per revolution main rotor frequency fail to meet the requirements of MIL-H-8501A paragraph 3.7.1(b) limit of 0.15 g at airspeeds of greater than 90 KCAS and power settings greater than 270 shp. The operator's manual should restrict use of the increased power available achieved by installation of the uprated main rotor transmission to airspeeds less than 90 KIAS.

HUMAN FACTORS

Cockpit Evaluation

44. Throughout these tests, the controls and indications for the 3-axis SCAS were evaluated relative to accessibility, location and design. Although the SCAS control panel was somewhat inaccessible due to its location beneath the collective, infrequent requirements to move these switches made this an acceptable location. The SCAS fail light (indication to the pilot that the SCAS has malfunctioned) was located at the top of the instrument panel directly in front of the pilot. For expedient test purposes the light was not a production configuration device, and was neither dimmable nor of military specification design. Bright sunlight obscured the illumination of the light and thus provided the pilot with little information. The lack of an easily seen SCAS fail light in bright sunlight is a shortcoming. The SCAS fail light function should be incorporated into the standard aircraft segmented caution panel and master caution system.

RELIABILITY AND MAINTAINABILITY

45. Throughout these tests, the reliability and maintainability characteristics of the 3-axis SCAS, improved tail rotor system and uprated main rotor transmission were observed. No specific tests were conducted to verify reliability and/or maintainability of these components during this short duration (calendar and flight hour) program. No failures were observed throughout these tests on any of the stated components. Within the scope of this evaluation, the reliability and maintainability characteristics of the OH-58C configured with 3-axis digital SCAS, improved tail rotor and uprated main rotor transmission are satisfactory.

CONCLUSIONS

GENERAL

46. The overall handling qualities of the OH-58C helicopter equipped with a 3-axis digital SCAS in either tail rotor configuration were significantly improved over the unaugmented aircraft configuration except as stated below. The combination of the SCAS and improved tail rotor reduced the standard aircraft characteristic uncommanded pitch, roll and yaw oscillations in left sideward flight from an unacceptable to an annoying level. The combination of the SCAS and standard tail rotor reduced the standard aircraft characteristic uncommanded pitch, roll and yaw oscillations, in left sideward flight, but were still excessive, i.e., a shortcoming rather than a deficiency (para 32 and 37).

SPECIFIC

47. The following specific conclusions were reached relative to the OH-58C aircraft equipped with an improved tail rotor:

a. Adequate directional control margins were available for sideward and rearward flight to the wind limits (35 KTAS sideward and 30 KTAS rearward) of the aircraft, up through a density altitude of 11,000 feet for a gross weight of 3,040 lb (para 31).

b. For the conditions tested, stable out-of-ground effect hover with the improved tail rotor required approximately four more engine shaft horsepower at low gross weight and three more shaft horsepower at high gross weight than with the standard tail rotor installation (para 11).

c. In accomplishing the same left yawing maneuver (during right sideward flight or hovering with a right crosswind) the transient and steady state tail rotor power increases were smaller for the improved tail rotor than for the standard tail rotor (para 27).

DEFICIENCIES

48. The following deficiencies were identified and are listed in decreasing order of importance.

a. The excessive pitch, roll and yaw attitude ($\pm$5 degrees) oscillations in left sideward flight of the OH-58C equipped with a 3-axis SCAS and standard tail rotor (para 37).

b. The excessive pitch, roll and yaw attitude ($\pm$8 degrees) oscillations in left sideward flight of the OH-58C equipped only with an improved tail rotor (SCAS OFF) (para 33).

SHORTCOMINGS

49. The following shortcomings were identified and are listed in decreasing order of importance.

a. The excessive aircraft vibration levels at airspeeds greater than 90 KCAS and power settings greater than 270 shaft horsepower (para 43).

b. The annoying pitch, roll and yaw attitude (±3 degree) oscillations observed (when the SCAS becomes saturated) in left sideward flight with the 3-axis SCAS and improved tail rotor (para 32).

c. The large longitudinal stick excursions required when executing steady turns (and during roll out of steady turns) (3-axis SCAS related) (para 17).

d. The degraded short-term rate damping characteristics observed during steady turns (3-axis SCAS related) (para 17).

e. The multiple directional control inputs required to establish directional trim (para 15).

f. The lack of an easily seen SCAS fail light in bright sunlight (para 44).

g. The lack of a directional control force gradient (para 12).

SPECIFICATION COMPLIANCE

50. As a result of this evaluation the following paragraphs of MIL-H-8501A were not met:

a. 3.7.1(b). The excessive vertical vibration levels at the 2 per revolution main rotor frequency failed to meet the limit of 0.15 g at airspeeds greater than 90 KCAS and power settings greater than 270 shp (para 43).

b. 3.3.10. Positive self-centering was not present in the directional control system (para 12).

RECOMMENDATIONS

51. If the SCAS and/or improved tail rotor are installed on the OH-58C aircraft, correct the deficiencies listed in paragraph 48.

52. If the SCAS and/or improved tail rotor are installed on the OH-58C aircraft, correct the shortcomings listed in paragraph 49.

53. The operator's manual should prohibit the use of the increased power available achieved by installation of the uprated main rotor transmission at airspeeds in excess of 90 KIAS (para 43).

54. The SCAS fail light function should be integrated into the standard aircraft segmented caution panel and master caution system (para 44).

APPENDIX A. REFERENCES

1. Letter, AVRADCOM, DRDAV-DI, 28 May 1983, subject: Test Directive No. 83-15, Preliminary Airworthines Evaluation of the OH-58C with 3-Axis Stability Augmentation System and Improved Tail Rotor System.

2. Test Plan, USAAEFA, Project No. 83-15, *Preliminary Airworthiness Evaluation of the OH-58C with 3-Axis Stability Augmentation System and Improved Tail Rotor System,* June 1983.

3. Letter, AVRADCOM, DRDAV-DI, 16 June 1983, subject: Advance Test Plan, Preliminary Airworthiness Evaluation of the OH-58C with 3-Axis Stability Augmentation System and Improved Tail Rotor System.

4. Letter, AVRADCOM, DRDAV-DI, 29 August 1983, subject: Test Directive No. 83-15, Preliminary Airworthiness Evaluation of the OH-58C with 3-Axis Stability Augmentation System and Improved Tail Rotor System.

5. Letter, USAAEFA, DAVTE-TB, 26 August 1983, subject: Test Plan for Additional Testing Required on USAAEFA Project No. 83-15.

6. Letter, AVRADCOM, DRDAV-DI, 31 August 1983, subject: Test Plan for Additional Testing Required on USAAEFA Project No. 83-15.

7. Technical Manual, TM 55-1520-235-10, *Operator's Manual Army Model OH-58C Helicopter*, 7 April 1978, with changes through 32 dated 6 June 1983.

8. Letter, AVRADCOM, DRDAV-D, 16 June 1983, subject: Airworthiness Release for Preliminary Airworthiness Evaluation of OH-58C Helicopter S/N 68-16850 with 3-Axis Stability Augmentation Improved Tail Rotor and Updated Transmission, USAAEFA Project No. 83-15.

9. Letter, AVRADCOM, DRDAV-D, 31 August 1983, subject: Airworthiness Release for Preliminary Airworthiness Evaluation of the OH-58C Helicopter S/N 68-16850 with 3-Axis Stability Augmentation, Improved Tail Rotor and Uprated Transmission, USAAEFA Project No. 83-15.

10. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling Qualities; General Requirements for,* 7 September 1961, with Amendment 1, 3 April 1962.

11. Naval Test Pilot School Flight Test Manual, Naval Air Test Center, USNTPS-FTM-No. 101, *Helicopter Stability and Control,* June 1968.

12. Engineering Design Handbook, Headquarters, US Army Material Command, AMCP 706-204, *Helicopter Performance testing*, August 1974.

13. Final Report, USAAEFA Project No. 76-11-2, *Airworthiness and Flight Characteristics Evaluation OH-58C Interim Scout Helicopter*, April 1979.

14. Final Report, USAAEFA Project No. 78-09, *Preliminary Airworthiness Evaluation OH-58C Helicopter with a Mast Mounted Sight*, May 1980.

APPENDIX B. AIRCRAFT DESCRIPTION

GENERAL

1. The helicopter is a standard OH-58C built by Bell Helicopter Textron (BHT). It has a single two-bladed, semi-rigid, teetering-type main rotor and a single two-bladed, delta hinged, semi-rigid teetering-type tail rotor. A detailed description of the OH-58C is contained in the operator's manual (ref 7, app A). The modifications for this test included the Bell 206L-3 tail rotor with accompanying drive shafting and gearbox, a shortened main rotor blade, and a three-axis digital, limited authority stability augmentation system.

WEIGHT AND BALANCE

2. The helicopter configured with all modifications and instrumentation was weighed with no fuel and with full fuel by BHT and witnessed by a USAAEFA quality control representative prior to the initiation of testing. The weight and longitudinal center of gravity (cg) data are presented below:

Empty fuel weight	2354 lb at FS 117.08
Full fuel weight	2811 lb at FS 117.64

Additional checks of the weight and longitudinal cg data were performed by BHT and monitored by USAAEFA quality control personnel throughout the testing.

CONTROL RIGGING

3. A complete flight control rigging check was performed by BHT and witnessed by USAAEFA quality control personnel prior to the initiation of testing. The tail rotor rigging was changed and rechecked when the standard tail rotor was installed and again when the improved was reinstalled. The data for the tail rotor rigging checks is presented in table 1.

Table 1. Tail Rotor Rigging

Tail Rotor	Direction	Blade Angle[1]
Improved Initial	Left Right	20° 16' -10.3'
Standard	Left Right	19° 04' -11° 41'
Improved Final	Left Right	20° 42' -9° 32'

NOTE:

[1]Geometric-pitch angle to the plane perpendicular to the rotor shaft

ROTOR SYSTEM

Tail Rotor

5. The 206L-3 tail rotor (improved tail rotor) incorporates the same airfoil section as the standard OH-58 tail rotor and is depicted in photo 1, however, the diameter is increased by 3 inches.

Tail Rotor Drive Shaft and Gearbox

6. The tail rotor drive shafting and gearbox is changed to the 206L-3 configuration. The drive shaft is a seven piece shaft. Each piece in the shaft (photo 2) is identical and has a larger diameter than the one-piece standard drive shaft. The tail rotor gearbox employs a continuous rating increase from 65 to 85 shaft horsepower (shp).

Main Rotor

7. In order to maintain main rotor to tail rotor clearance, each main rotor tip cap was shortened by 1.5 inches. The tip cap modification is shown in photo 3.

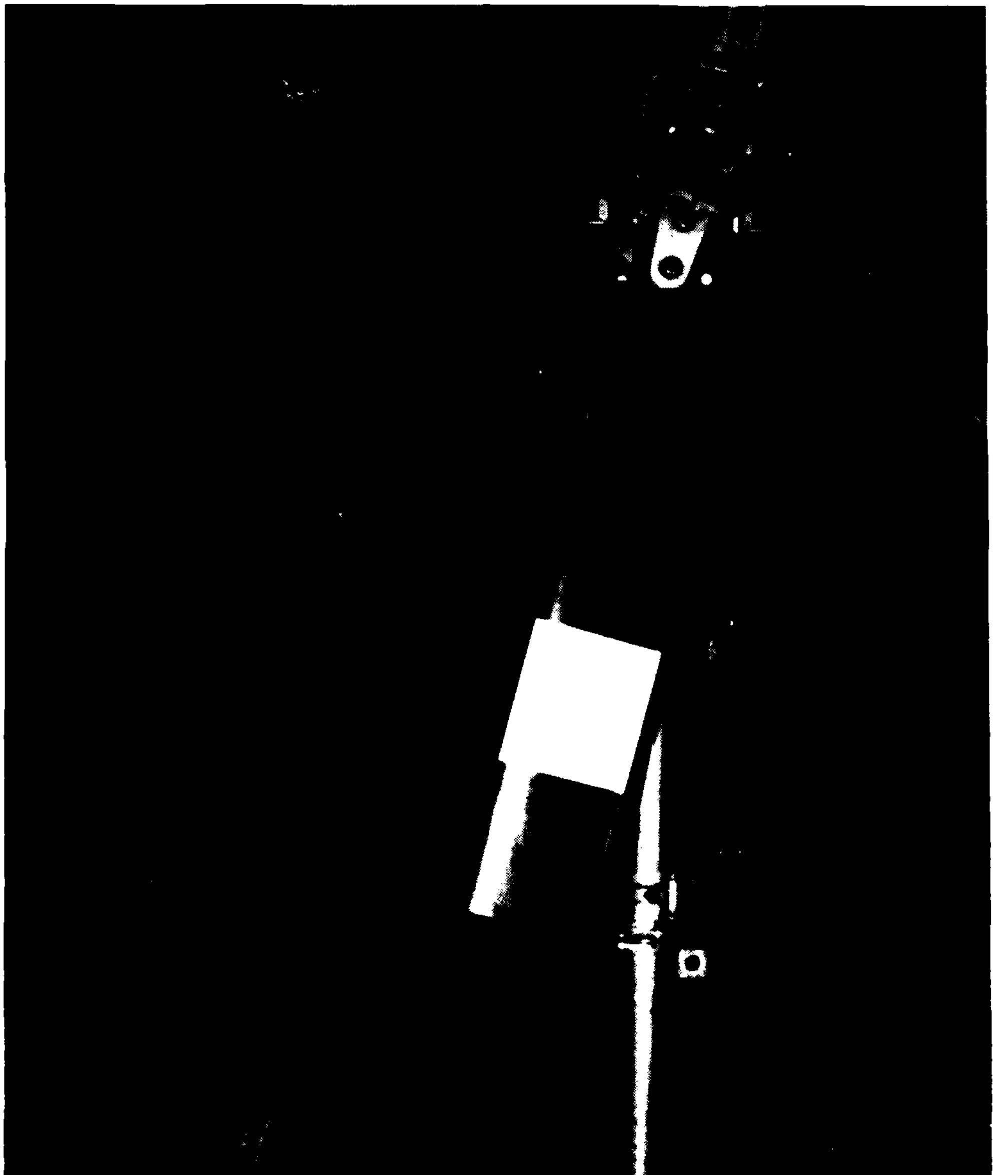


Photo 1. Improved Tail Rotor

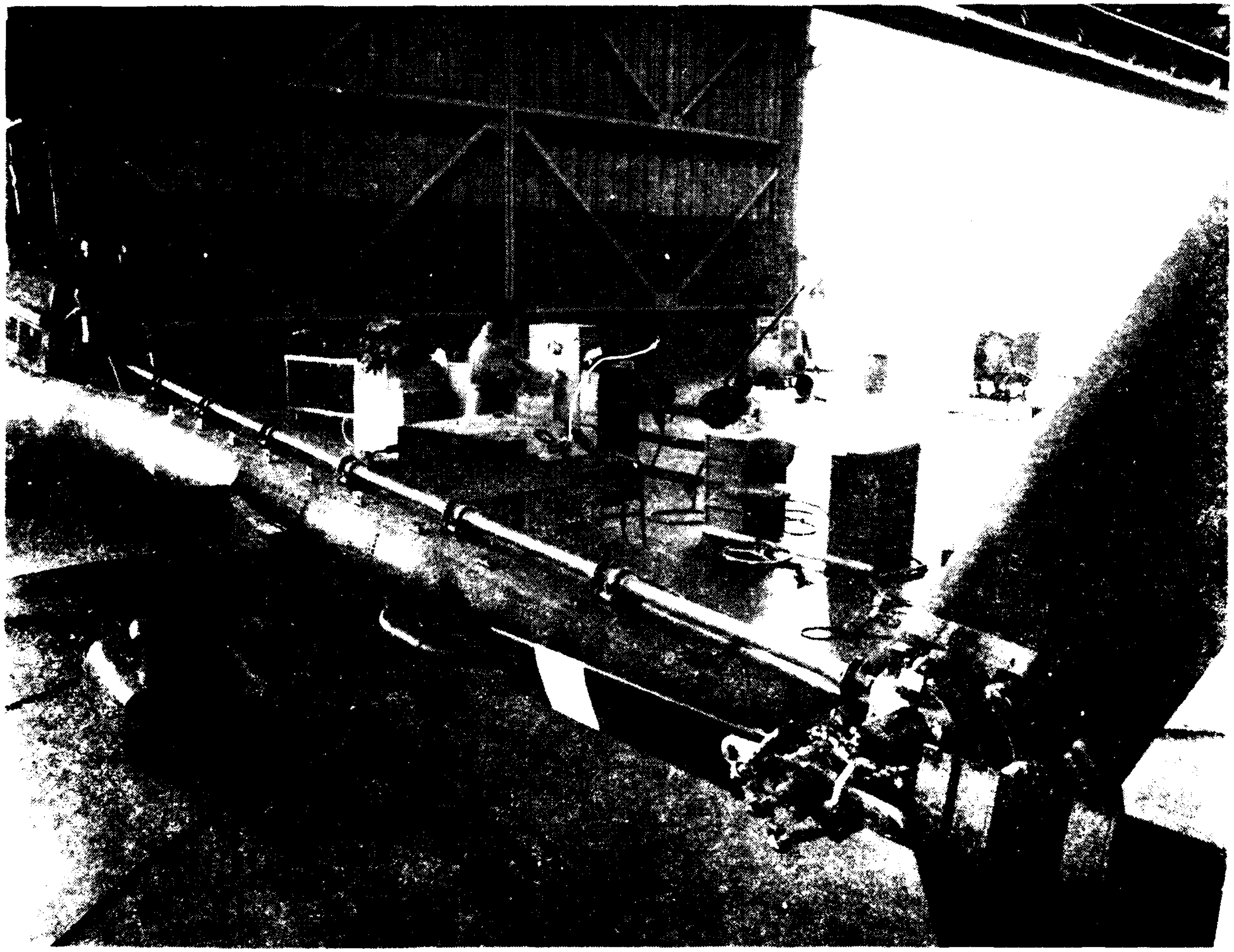


Photo 2. Improved Tail Rotor Drive System

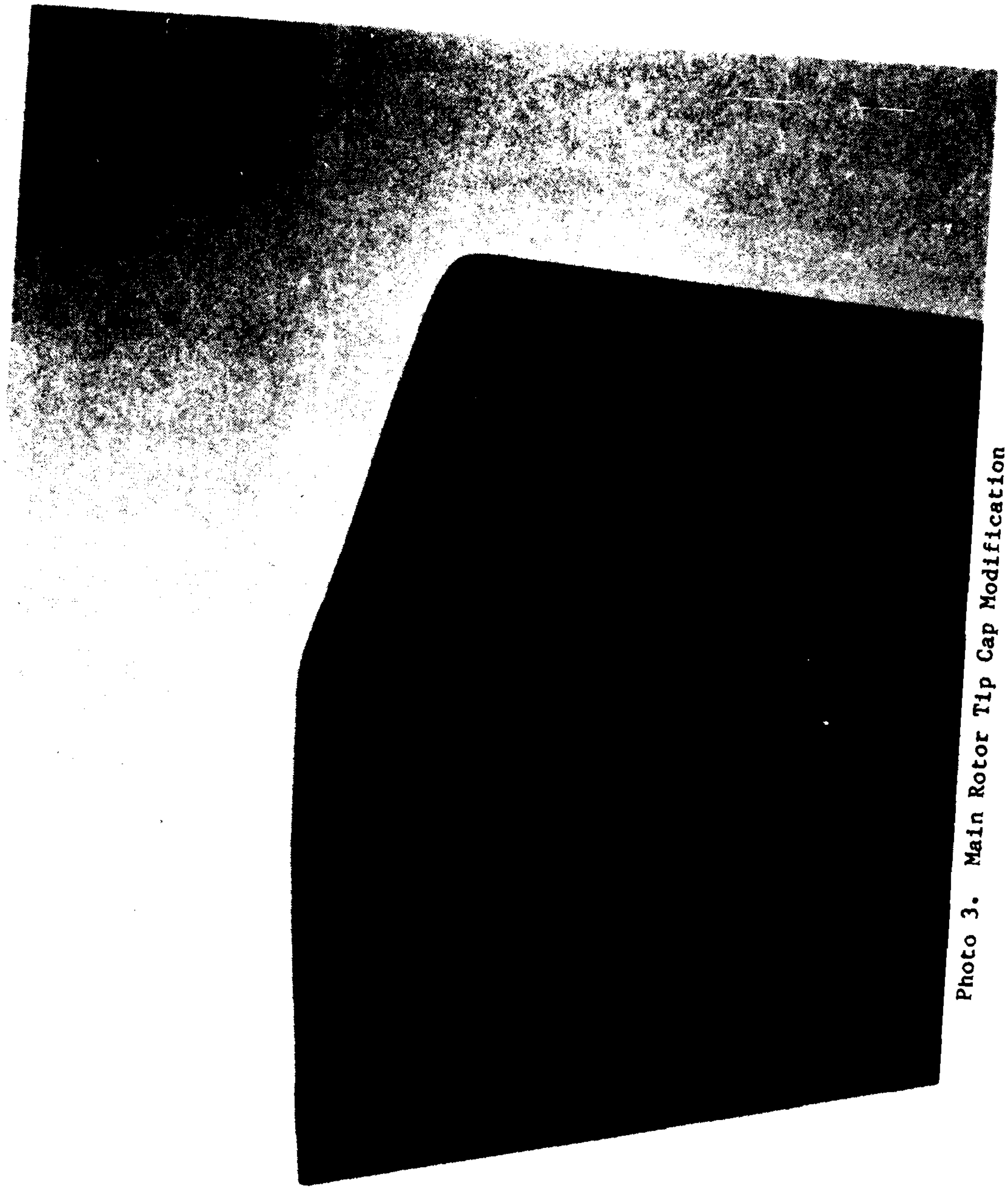


Photo 3. Main Rotor Tip Cap Modification

STABILITY AND CONTROL AUGMENTATION SYSTEM

General

8. The standard configuration OH-58C was modified by adding a stability and control augmentation system (SCAS). This SCAS is a 3-axis, fail-safe (electrically shut down and actuators centered) control system which uses rate gyro, control motion, and airspeed inputs. The system is fail-operate (the malfunctioning system is electrically isolated) in the yaw axis for the first sensor or computer failure and fail-safe for subsequent yaw axis failures and all cyclic failures. The system includes the following components:

	Part No.	Qty/ Ship	Location
SCAS Control Panel	206-078-255-101	1	Pedestal
Flight Control Computer	206-078-200-101	2	Baggage Compartment
2-Axis Rate Gyro Package*	406-074-001-101	4	Baggage Compartment
Dual Control Motion Transducer	214-074-108-101	4	Under Copilot Seat
Airspeed Transducer	214-074-152-101	1	Nose
Cyclic Hydraulic Actuator*	406-076-101-101	2	Roof
Directional Hydraulic Actuator*	406-076-102-1-1	1	Entrance to Tailboom
250VA Inverter	206-375-001-101	2	Baggage Compartment

*Components common to the OH-58D.

The preceding components are interconnected as shown by the block diagrams of figures 1 and 2.

Control Panel

9. The SCAS control panel is shown in figure 3. The panel includes a power switch, a pushbutton test switch, two magnetically held engage switches, and 6 fail annunciators. The HDG

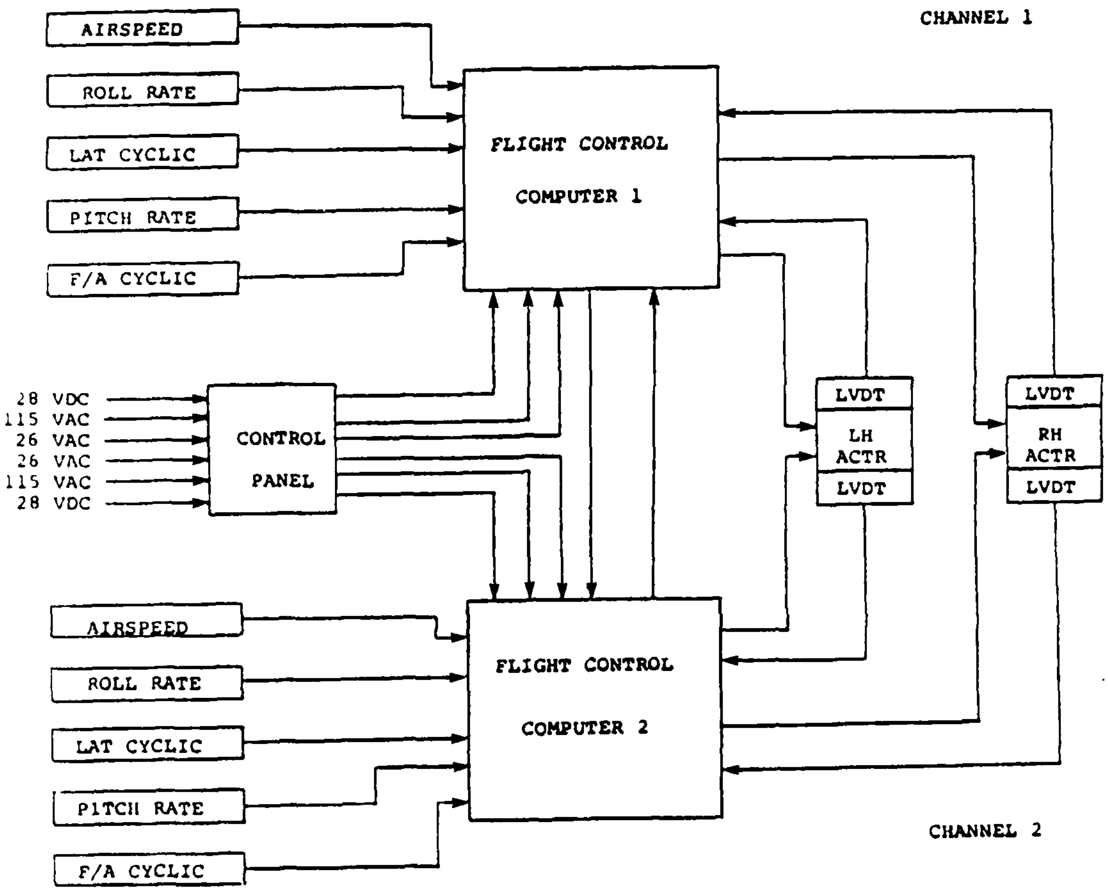


Figure 1. Pitch and Roll SCAS Block Diagram

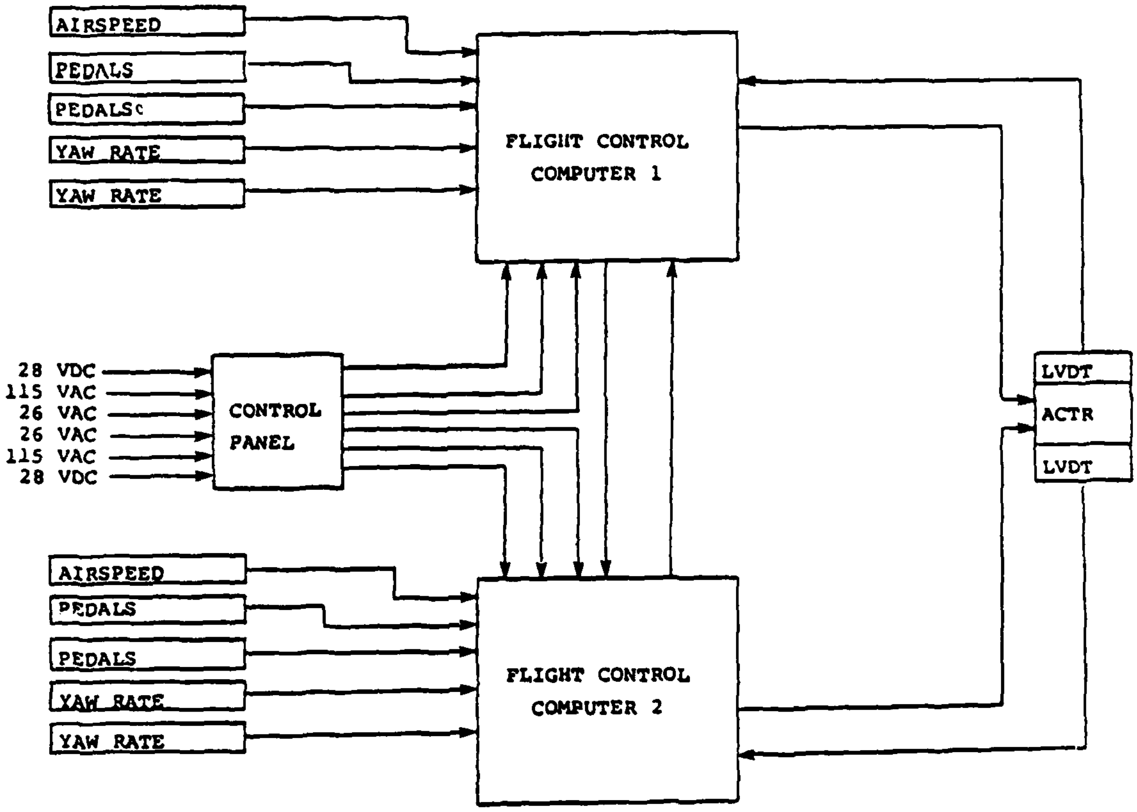


Figure 2. Yaw SCAS Block Diagram

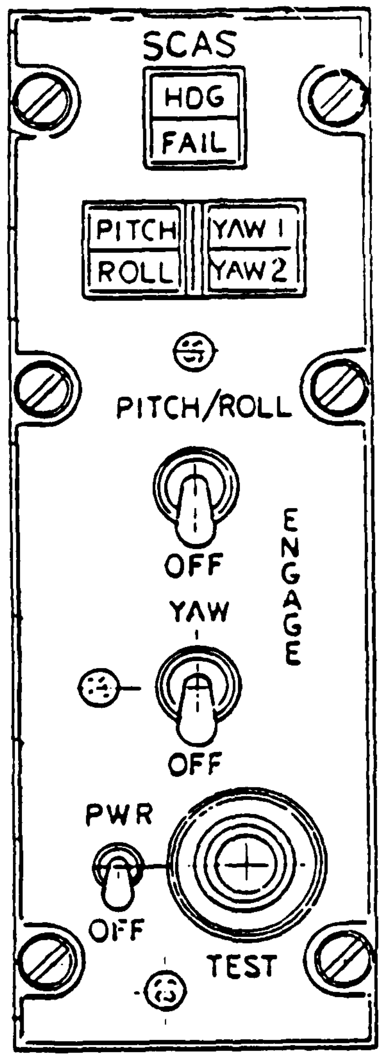


Figure 3. SCAS Control Panel

fail annunciator is not used and will not be visible to the pilot.

Electrical Power Distribution

10. The SCAS power distribution is shown in figure 4. Proper operation of the SCAS requires the inverter switch and the circuit breakers listed below to be closed.

SCAS Circuit Breakers

INV 1
INV 2
SCAS 1 26 VAC
SCAS 1 115 VAC
SCAS 2 115 VAC
SCAS 1 DC
SCAS 2 DC

Actuator Solenoid Schematics

11. The actuator solenoid schematics are shown in figures 5 and 6. The switches labeled FCC 1 and FCC 2 are solid-state switches located in and controlled by the flight control computers. The difference between the yaw axis and the cyclic axes is that the computer switches are connected in parallel for yaw and in series for cyclic. This allows the yaw axis to continue to operate after a single computer failure (fail-operate).

In-flight Failure Monitoring

12. While the system is engaged, both flight control computers periodically perform failure detection tests as follows:

a. Input signal reasonableness (within a predetermined tolerance) checks - Outputs of airspeed transducers, rate gyros, control motion transducers, and actuator position transducers are checked for voltage levels out of normal range.

b. Command calculation comparisons - The pitch command calculated in Computer 1 is compared to the pitch command calculation in Computer 2. An unreasonable difference (outside a predetermined tolerance) between the two calculations results in disengagement (fail-safe) of the pitch axis. A similar comparison is made for the roll axis. Figures 7 and 8 depict the pitch and roll SCAS systems.

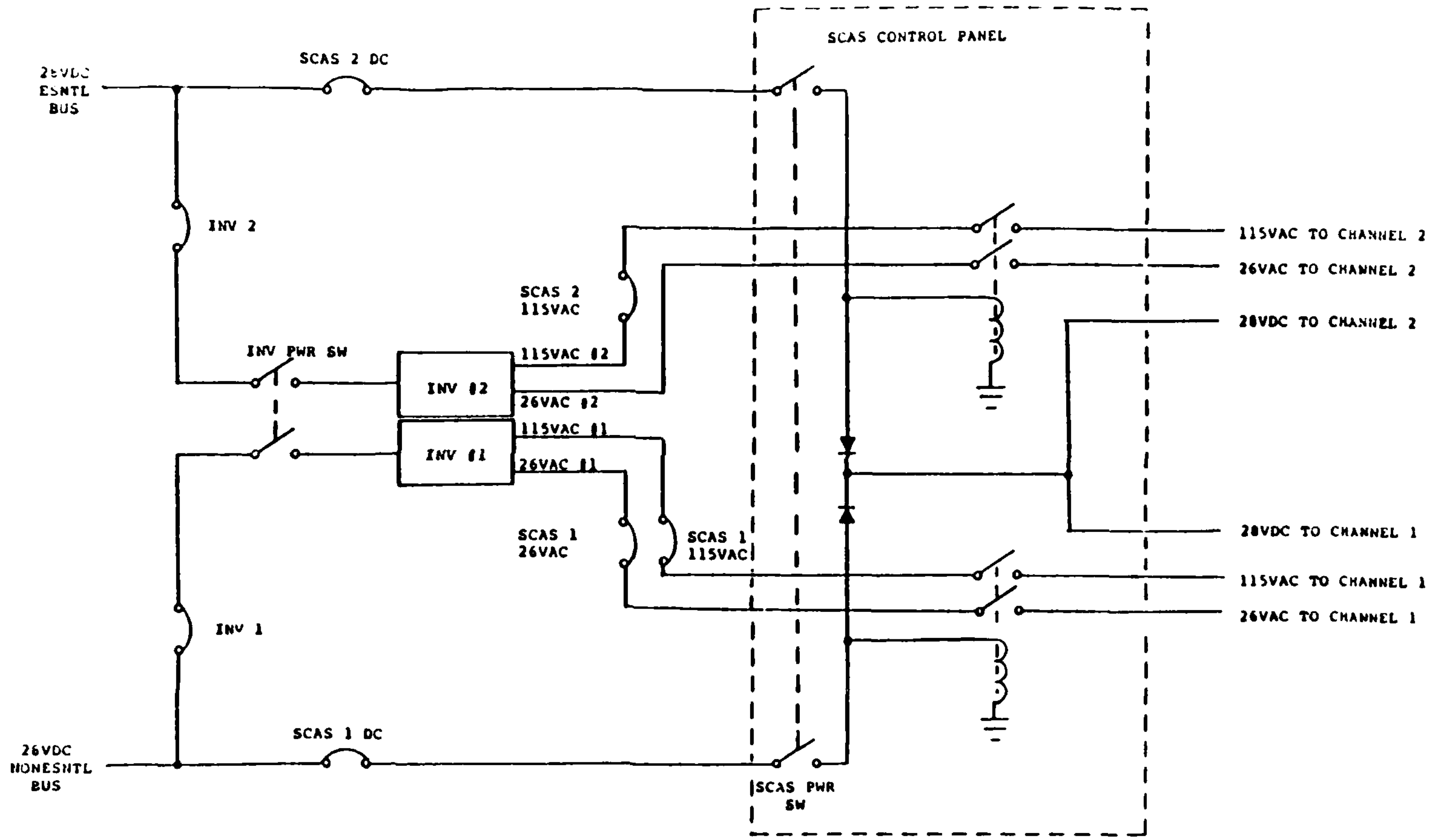


Figure 4. SCAS Power Distribution Schematic

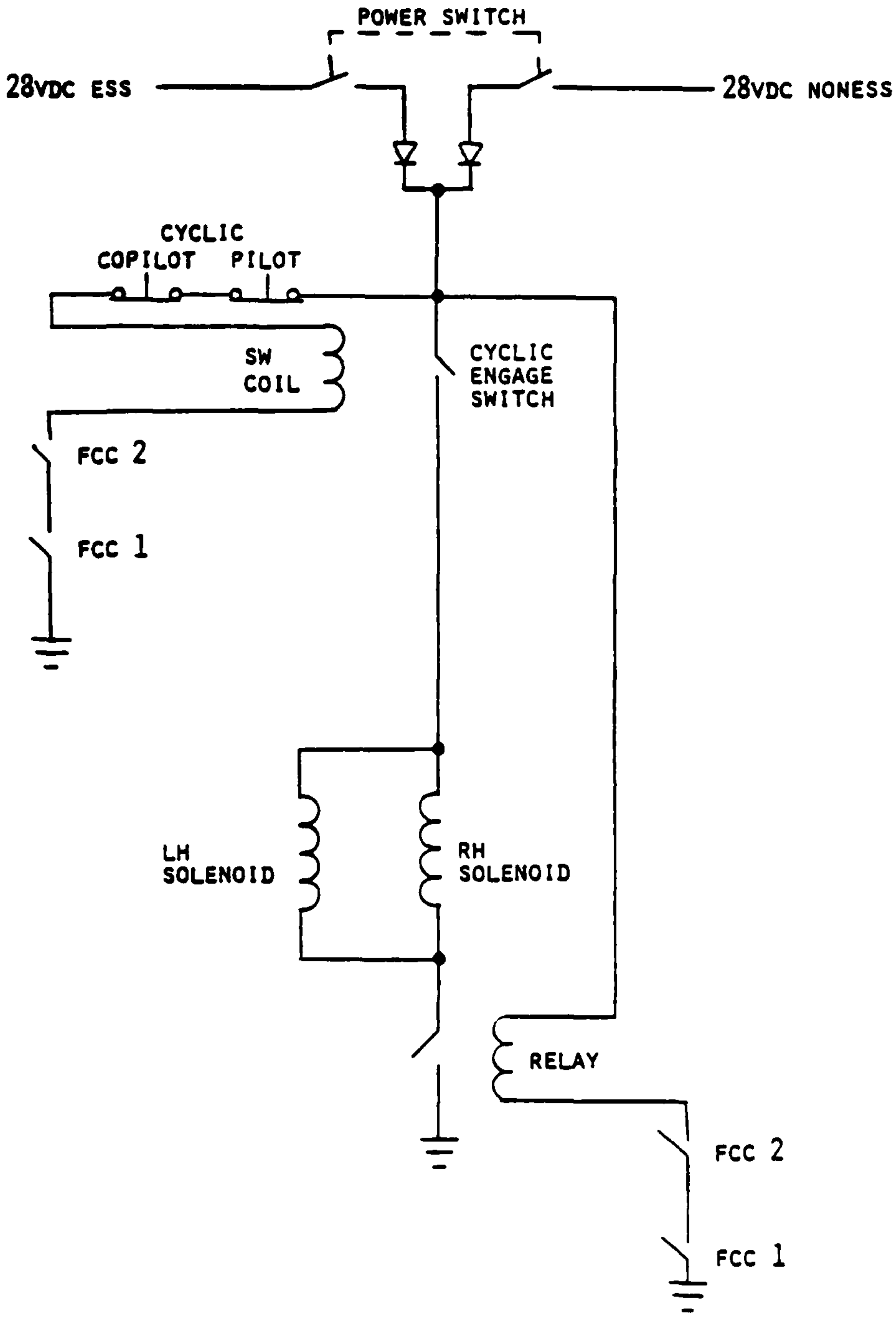


Figure 5. Cyclic Solenoid Schematic

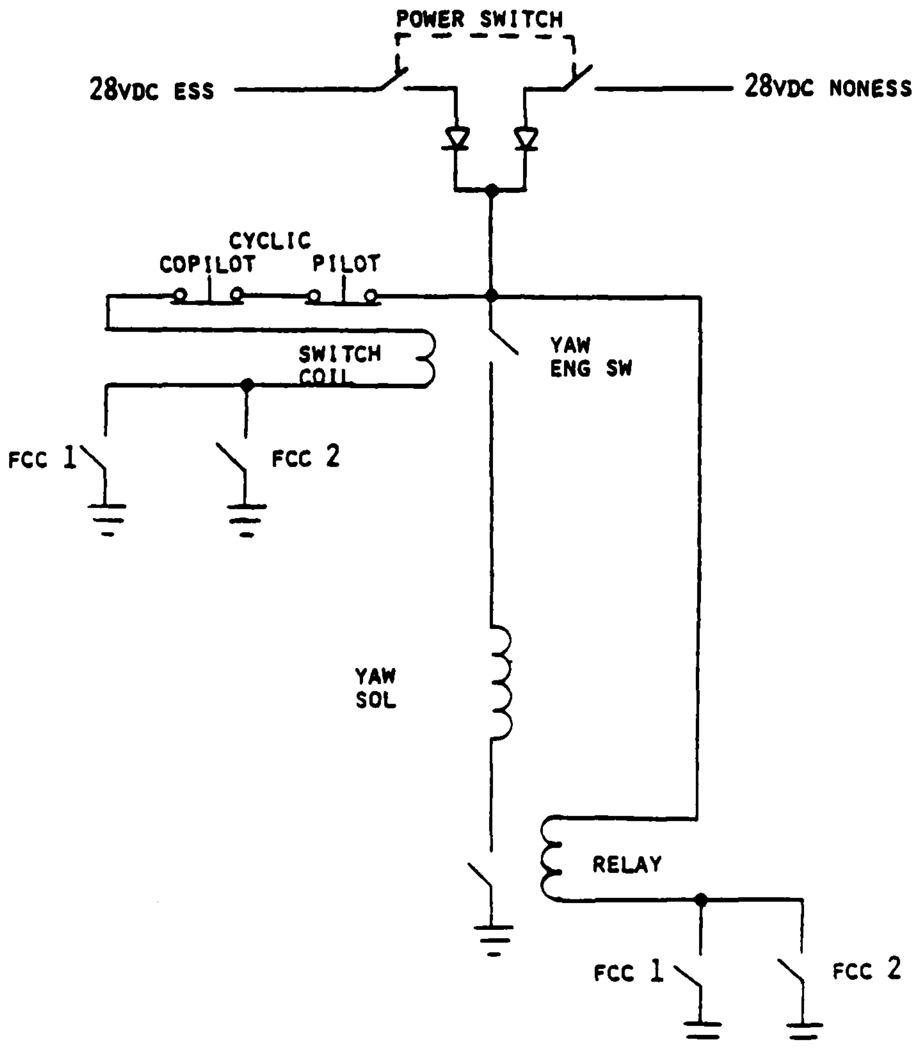


Figure 6. Yaw Solenoid Schematic

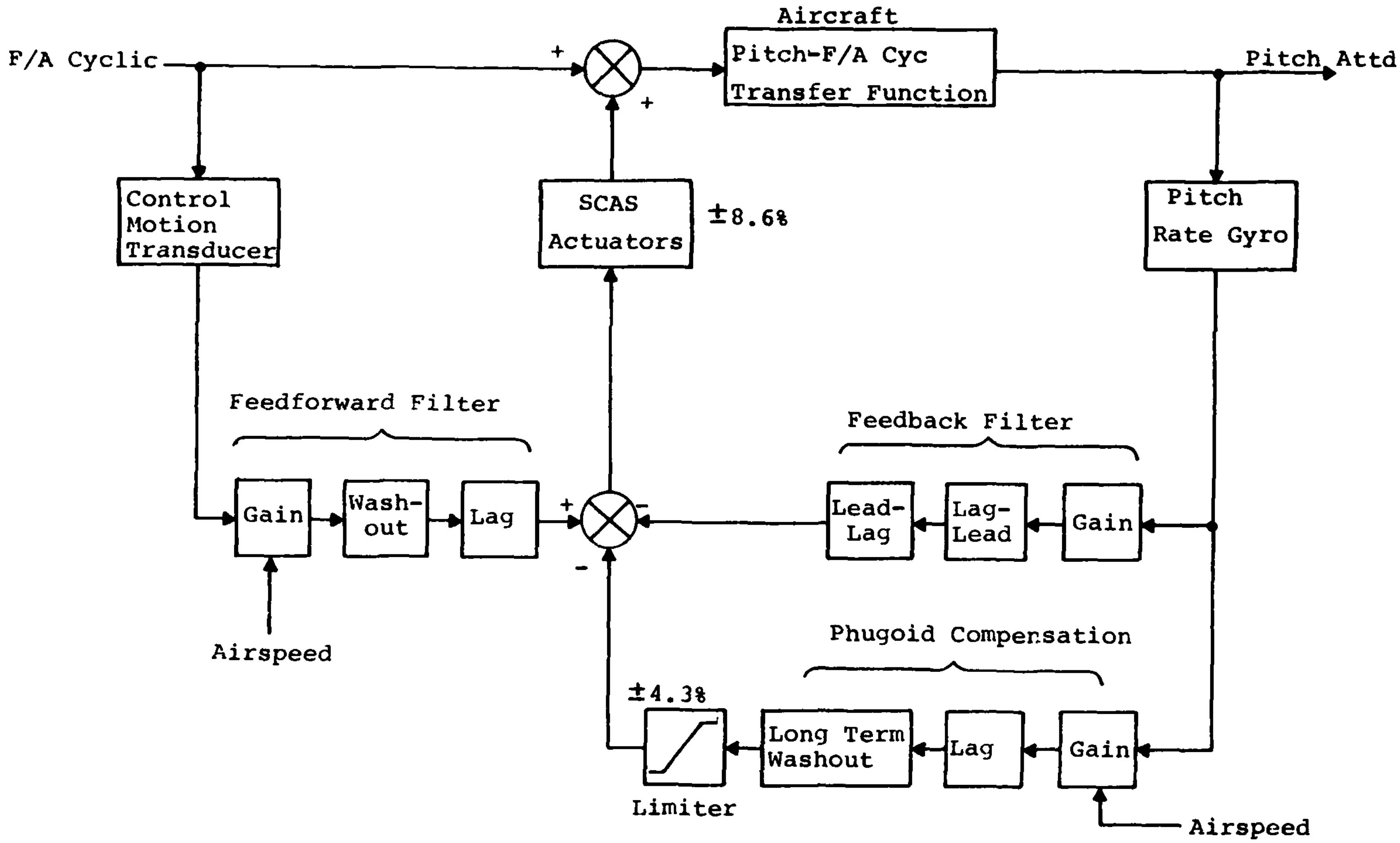


Figure 7. Pitch SCAS Block Diagram

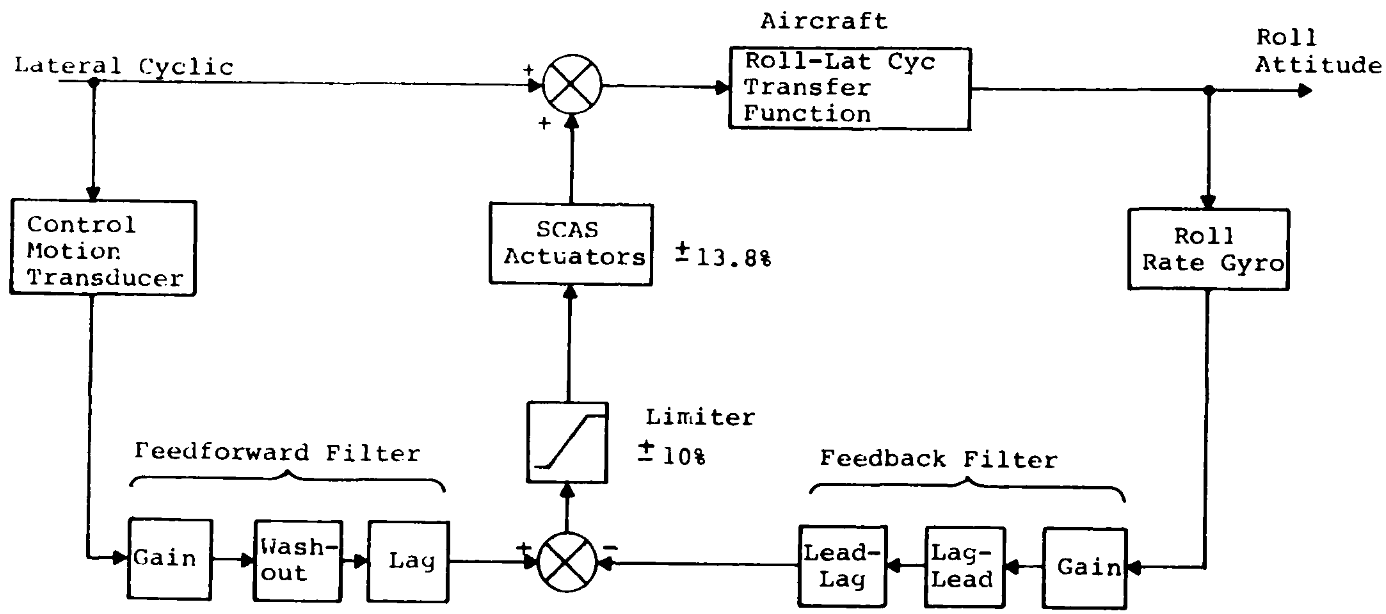


Figure 8. Roll SCAS Block Diagram

c. Input signal comparisons - The yaw axis has two control motion inputs and two rate gyro inputs to each computer. Like inputs are compared, and if the difference between inputs is unreasonable, the yaw axis for the affected computer is disengaged. Figure 9 depicts the yaw SCAS system.

d. Actuator position/expected actuator position comparisons - Each computer calculates "expected" actuator positions for all three actuators. If there is an unreasonable difference between the measured and expected actuator position for either cyclic actuator, both pitch and roll axes are disengaged. An unreasonable difference between the measured and expected actuator position for the yaw actuator results in disengagement of the yaw axis.

e. Timeout timer - Each computer has a timeout timer that has to be reset on a regular basis. If a computer malfunctions, the timer will not be reset, and pitch and roll will be disengaged, and yaw will remain engaged if the other computer is functional.

Failure codes are stored in nonvolatile memory for checks a through d above. These failure codes can be retrieved and interpreted by maintenance personnel.

13. The fail annunciators on the SCAS control panel are used to indicate both in-flight failures and failures during the preflight tests. The position of the engage switches and the condition of the fail annunciators are indications of which axes of SCAS are operational. If the PITCH/ROLL engage switch is in the off position, there will be no stabilization about the pitch and roll axes, regardless of the condition of the pitch and roll annunciators. If the PITCH/ROLL engage switch is in the "engaged" position, illumination of PITCH or ROLL indicates loss of stabilization for the illuminated axis. Failures which affect both pitch and roll will cause illumination of both PITCH and ROLL annunciators and the disengagement of the PITCH/ROLL engage switch. This will cause both cyclic actuators to center and lock. The yaw SCAS is functional as long as the YAW engage switch is in the "engaged" position. Illumination of YAW 1 and YAW 2 indicates a loss of yaw actuator input from one computer. However, there should be no noticeable change in yaw SCAS performance. A failure or failures which cause both YAW 1 and YAW 2 annunciators to illuminate will also cause the YAW engage switch to drop to the off position. This will cause the yaw actuator to center and lock.

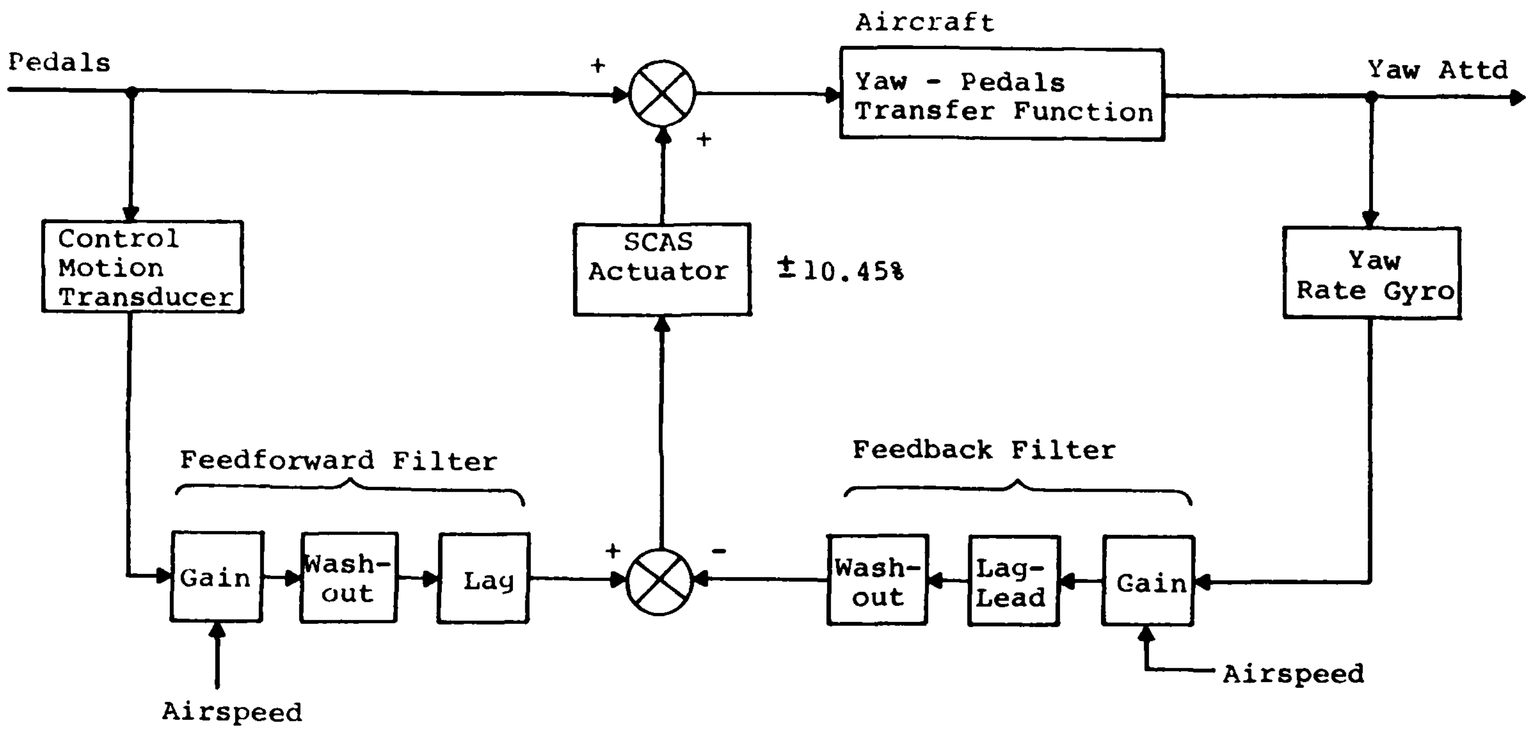


Figure 9. Yaw SCAS Block Diagram

Actuators

14. The SCAS uses 2 cyclic actuators BHT P/N (406-076-101-101) and 1 yaw actuator BHT P/N (406-076-102-101) (photo 4). These actuators are hydraulic actuator assemblies which include a boost actuator and a SCAS actuator. The SCAS actuator includes a dual coil electrohydraulic servovalve, a solenoid valve, centering springs, and locks. Because the servovalve has two coils, it can be driven by both flight control computers. The solenoid valve is used to activate the SCAS actuator. If the solenoid valve is deenergized, the SCAS actuator will center and lock.

SCAS Actuator Authorities

15. The SCAS actuator strokes are limited to give the following SCAS authorities of full control travel.

Pitch	± 8.6%
Roll	±13.8%
Yaw	±10.4%

The roll command to the cyclic actuators is electrically limited so that the effective roll authority is ±10%.

SCAS Release Switch

16. SCAS release switches are located on the pilot and copilot cyclic grips as shown in figure 5. If either switch is depressed, all axes of SCAS will disengage.

SCAS Advisory Light

17. A SCAS advisory light is provided on the pilot's side of the instrument panel. The purpose of the light is to inform the pilot that the SCAS is disengaged or has malfunctioned.

SYSTEM OPERATION

Normal Operation

18. Normal preflight testing and engagement of SCAS should be accomplished using the procedure of table 2. The procedure should not be initiated until inverter and hydraulic caution lights are extinguished. Steps 1 through 7 should be completed on the first flight of the day. For subsequent flights, steps 3 through 6 may be omitted.

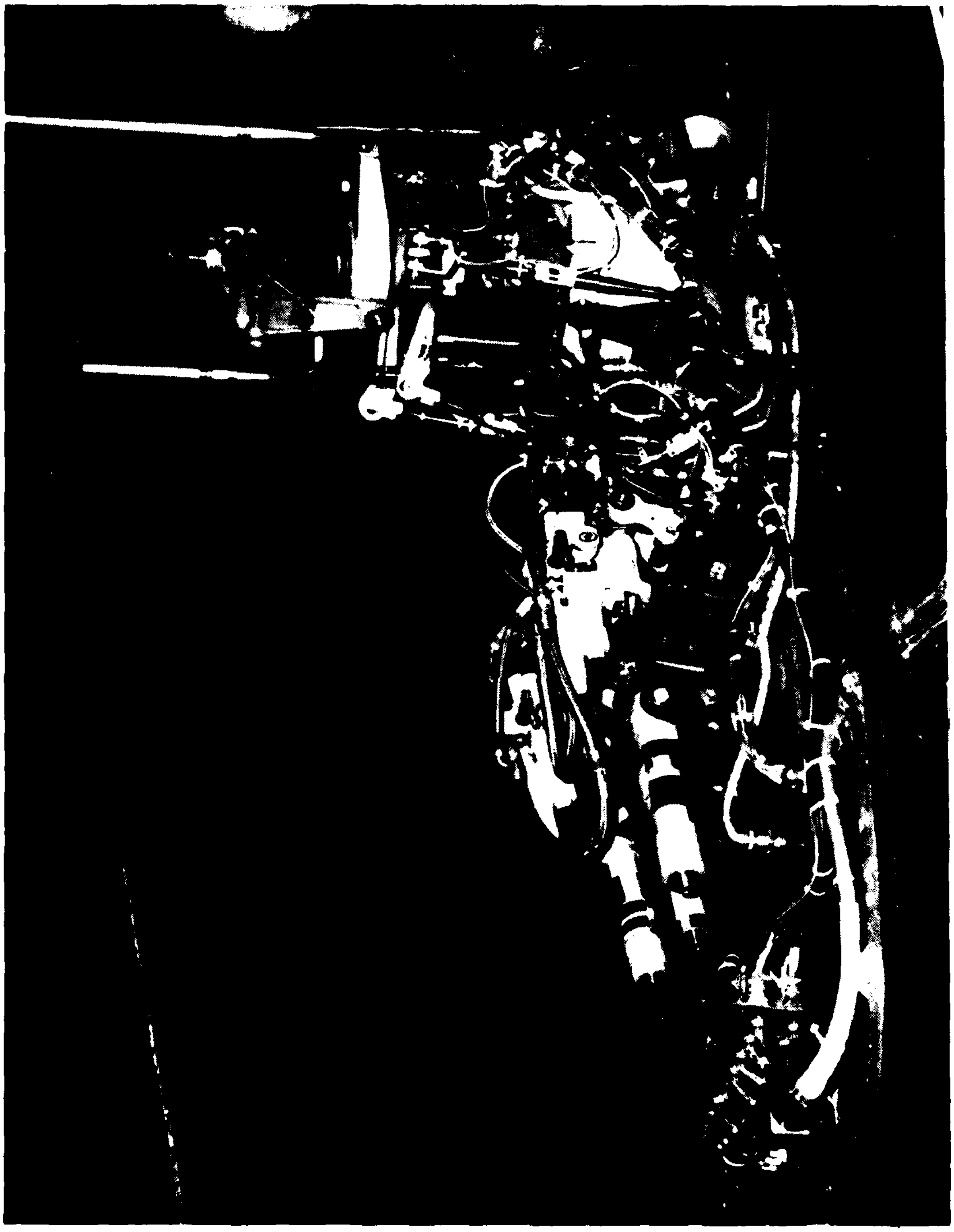


Photo 4. Cyclic Actuator Installation

Table 2. Preflight Tests

	Action	Normal Indication
1.	Turn on power switch on SCAS control panel	Pitch, roll, yaw 1 and yaw 2 annunciators on the SCAS control panel illuminate. SCAS advisory light on instrument panel illuminates.
2.	Press test switch on SCAS control panel	Pitch, roll, yaw 1 and yaw 2 annunciators extinguish and then illuminate momentarily for approximately 3 seconds.
3.	Engage pitch/roll and yaw	Both engage switches remain in the "engaged" position. The SCAS advisory light and all annunciators on the control panel are extinguished.
4.	Press test switch on SCAS control panel	Both engage switches drop to the off position, and the pitch, roll, yaw 1, yaw 2 and fail annunciators illuminates momentarily twice. The SCAS advisory light illuminates.
5.	Engage pitch/roll and yaw	Both engage switches remain in the "engaged" position. The SCAS advisory light and all annunciators on the control panel are extinguished.
6.	Press SCAS release switch on cyclic grip.	Both engage switches drop to the off position, and the SCAS advisory light illuminates.
7.	Engage pitch/roll and yaw	Both engage switches remain in the "engaged" position. The SCAS advisory light and all annunciators on the control panel are extinguished.

Abnormal Operation

19. If the procedure of table 1 is performed and results other than the ones given in the normal indication column occur, the SCAS may still be partially functional. It is permissible to attempt engagement even if one or more of the control panel annunicators remain illuminated after the completion of a test. If a critical check is failed during the tests, the appropriate axes are prevented from engagement by the computers. This will result in the appropriate fail annunciators being illuminated and possibly an engage switch or switches which will not remain in the "engaged" position. The illumination of the FAIL annunciator by itself is an indication that a fail code is stored in memory, but the system should be operational in all three axes. The fail code can be cleared by maintenance personnel.

Shutdown Procedure

20. After landing the helicopter and before engine shutdown, the pilot should note the condition of the engage switches and the annunciator lights on the SCAS control panel. If any annunciators are illuminated or either engage switch is off or any problems occurred in flight, the pilot should notify maintenance personnel. After checking the condition of the control panel, the pilot should move the SCAS power switch to the off position.

SCAS Disengagement

21. The SCAS can be disengaged by any of the following actions.

a. Moving engage switch to off (pitch/roll or yaw).

b. Moving power switch on SCAS control panel to off (all axes disengaged).

c. Pressing SCAS release switch on cyclic grip (all axes disengage).

Disengagement of the SCAS by methods a and c will cause the SCAS advisory light to illuminate, but it will not affect the annunciators on the SCAS control panel. Method b will extinguish all SCAS lights.

SCAS Advisory Light

22. A SCAS advisory light is installed on the pilot's side of the instrument panel. The light will come on when the SCAS power switch is turned on, and it will remain on until all axes are engaged. It will come on again if the system is disengaged by

the pilot or a failure occurs which eliminates the pitch, roll, or yaw contribution from either computer. If at least one engage switch is in the "engaged" position, the advisory light can be extinguished by pressing the test switch on the control panel.

Reengagement After a Failure

23. If a failure occurs during flight, the affected channel can be reengaged according to the procedure of table 3.

Table 3. Procedure for Reengagement After a Failure

Action	Normal Indication
1. Momentarily press SCAS release switch on cyclic grip	Both engage switches are in off position. SCAS advisory light is illuminated. One or more annunciators on SCAS control panel are illuminated.
2. Momentarily press test switch on SCAS control panel	Illuminated SCAS annunciators extinguish momentarily, and then pitch, roll, yaw 1, and yaw 2 annunciators illuminate for 3 seconds. At the end of the 3 second period, pitch, roll, yaw 1, and yaw 2 extinguish, and the FAIL light illuminates.
3. Engage pitch/roll and yaw	Both engage switches remain in the "engaged" position. The SCAS advisory light extinguishes.

APPENDIX C. INSTRUMENTATION

GENERAL

1. The test instrumentation was installed, calibrated and maintained by Bell Helicopter Textron (BHT). Data was obtained from calibrated instrumentation and was recorded on magnetic tape and/or displayed in the cockpit. The data acquisition system consisted of various transducers, signal conditioning units, frequency multiplexing techniques, and a 1 inch, 14-track Inter-Range Instrumentation Group intermediate band recorder. Various specialized indicators displayed data to the pilot and engineer on board the aircraft continuously during the flight. A flight test boom (photo 1) was mounted on the nose of the aircraft with the following equipment: swiveling pitot-static tube, sideslip vane, angle-of-attack vane, and total temperature sensor.

2. Cockpit monitored parameters:

Pilots Panel (photo 2)

Airspeed (boom)
Altitude (boom)
Altitude (radar)*
Rate of climb*
Rotor speed (sensitive)
CG normal acceleration
Horizontal situation indicator*
Engine torque pressure (digital)
Main rotor flapping angle
Angle of sideslip
Yaw rate
Left cyclic SCAS actuator position
Right cyclic SCAS actuator position
Directional SCAS actuator position
Event Switch

Copilots Panel (photo 3)

Gas producer speed (N_g)*
Turbine outlet temperature (TOT)*
Fuel quantity**
Airspeed**
Control positions
    Longitudinal
    Lateral
    Directional

* Ship's system/not calibrated
** Ship's system/calibrated

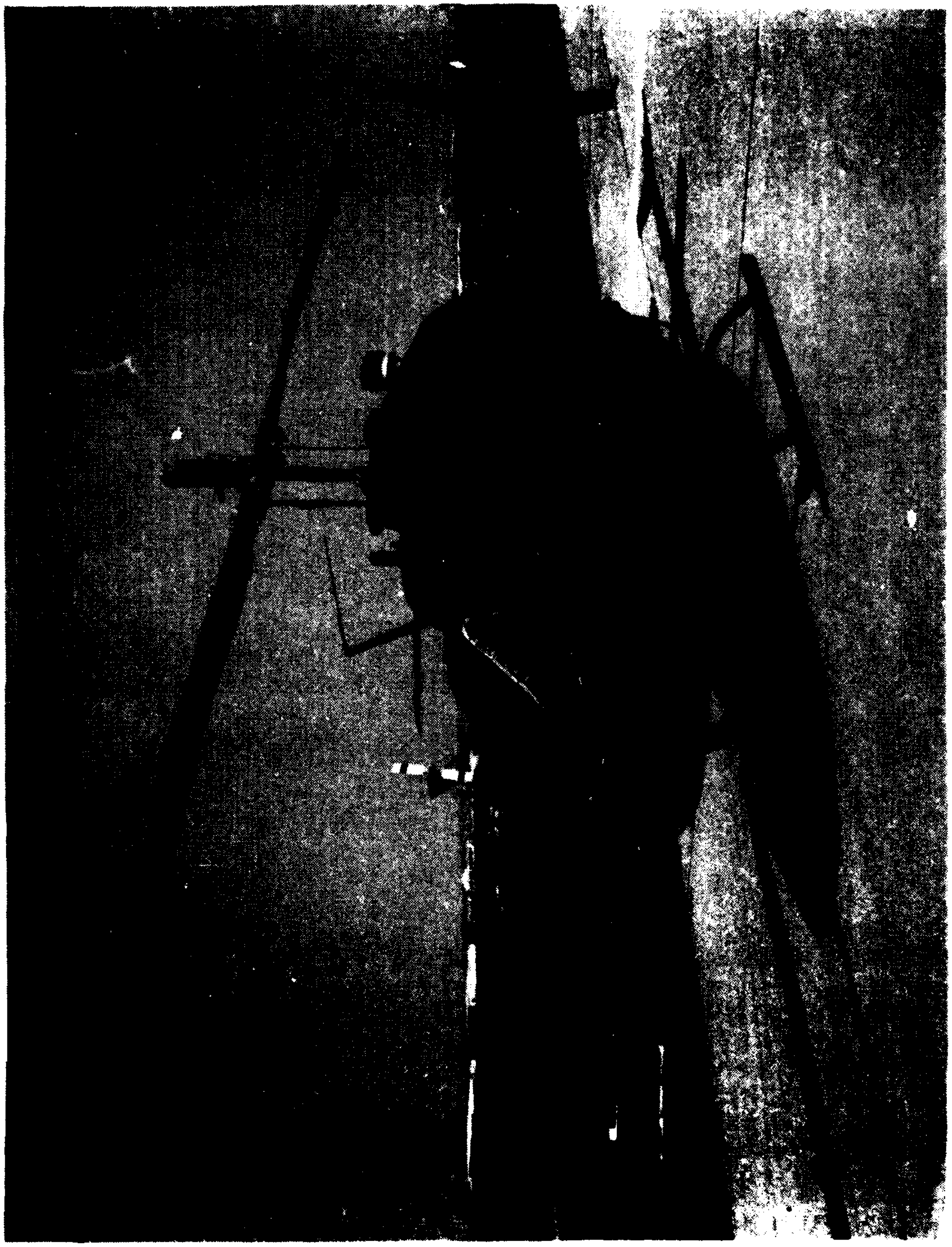


Photo 1. Pitot-Static Boom Installation

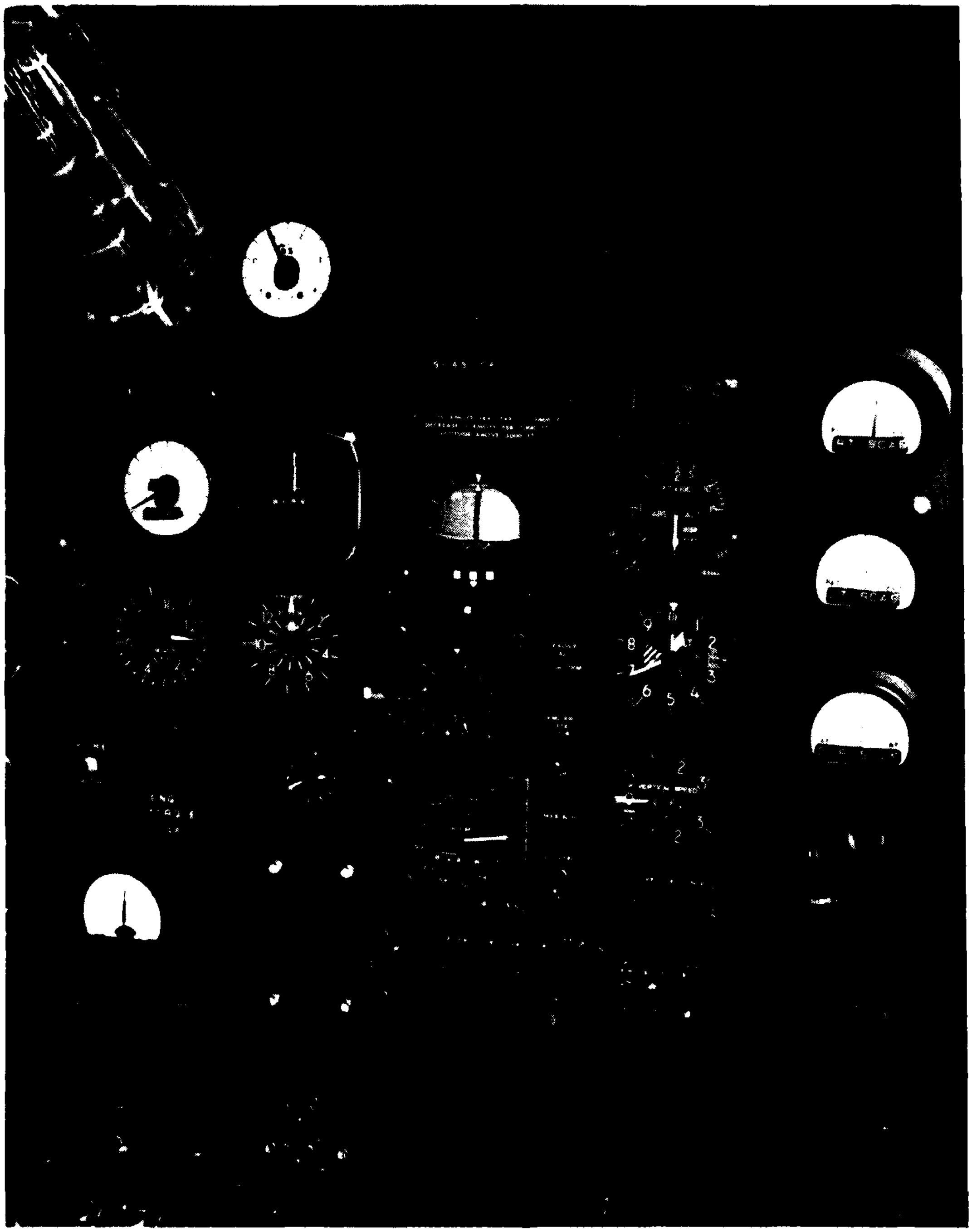


Photo 2. Pilot Instrument Panel

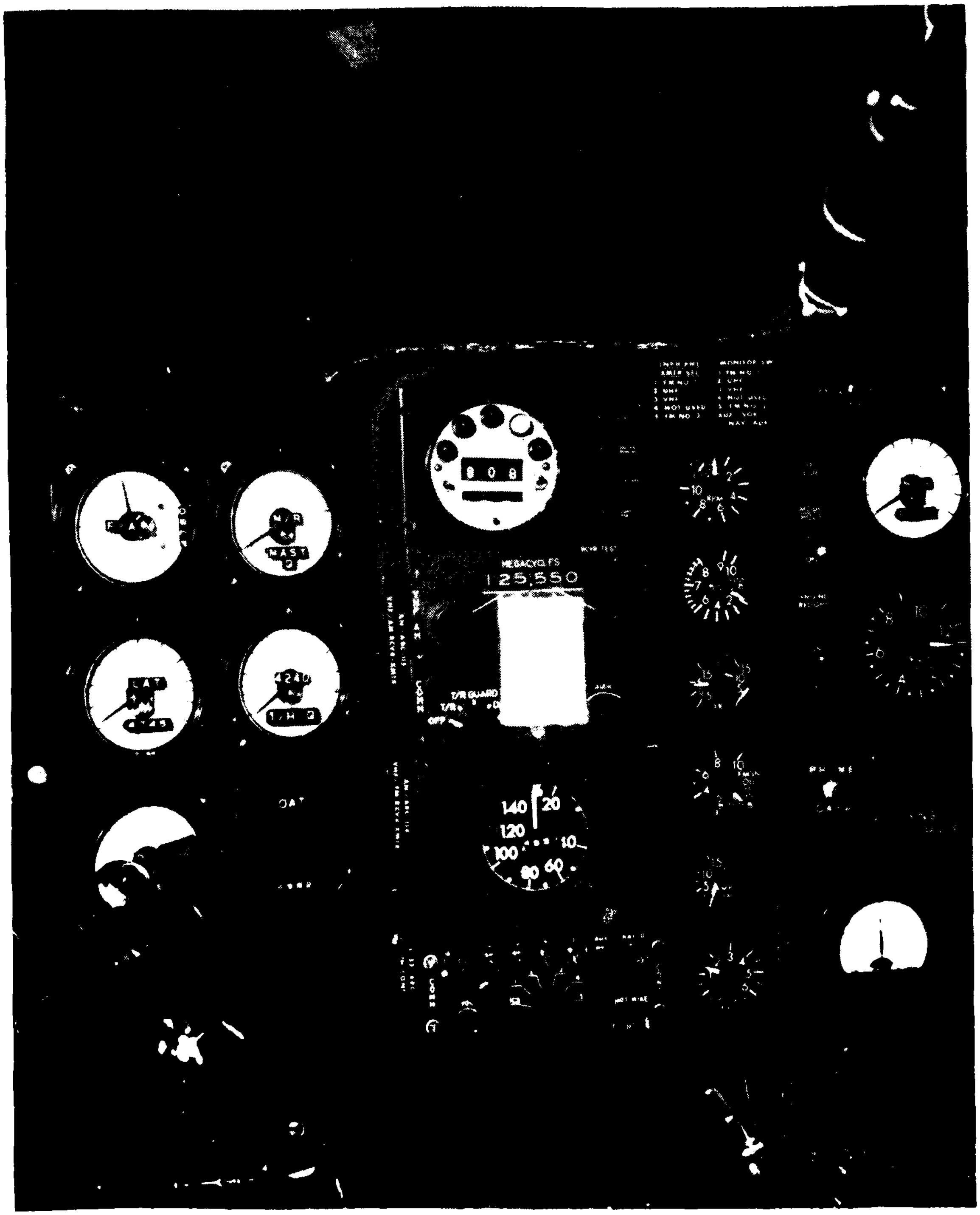


Photo 3. Copilot Instrument Panel

Main rotor mast torque
Tail rotor mast torque
Ambient air temperature
Fuel used counter
Instrumentation controls
Record counter

Center Console

Collective control position
SCAS hardover control (photo 4)

3. Parameters recorded on tape were as follows: (photo 5)

Airspeed (boom)
Altitude (boom)
Attitudes
    Pitch
    Roll
    Yaw
Rates
    Pitch
    Roll
    Yaw
Angle-of-sideslip
Angle-of-attack
Control positions
    Longitudinal
    Lateral
    Directional
    Collective
    Throttle
SCAS actuator position
    Left cyclic
    Right cyclic
    Directional
Accelerometers (vibration)
    Center of gravity
        Longitudinal (FS 123.0, BL 0.0, WL 68.0)
        Vertical (FS 123.0, BL 0.0, WL 68.0)
    Pilots seat support structure
        Longitudinal (FS 63.0 BL 17.0, WL 21.0)
        Lateral (FS 63.0, BL 17.0, WL 21.0)
        Vertical (FS 65.0, BL 17.0, WL 21.0)
    Copilots seat support structure
        Vertical (FS 64.0, BL -14.5, WL 21.0)
Engine torque pressure
Rotor speed

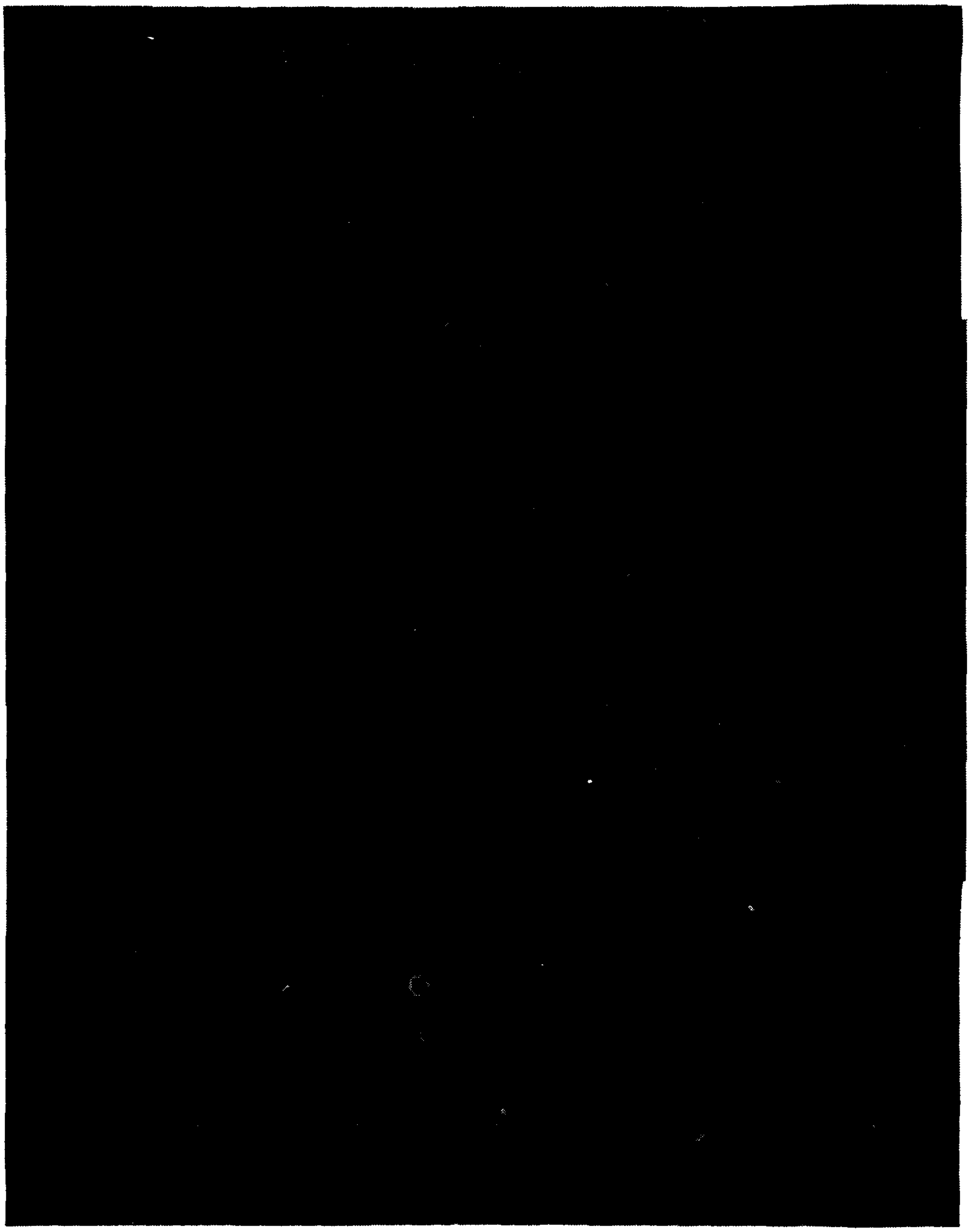


Photo 4. SCAS Hardover Injection Control

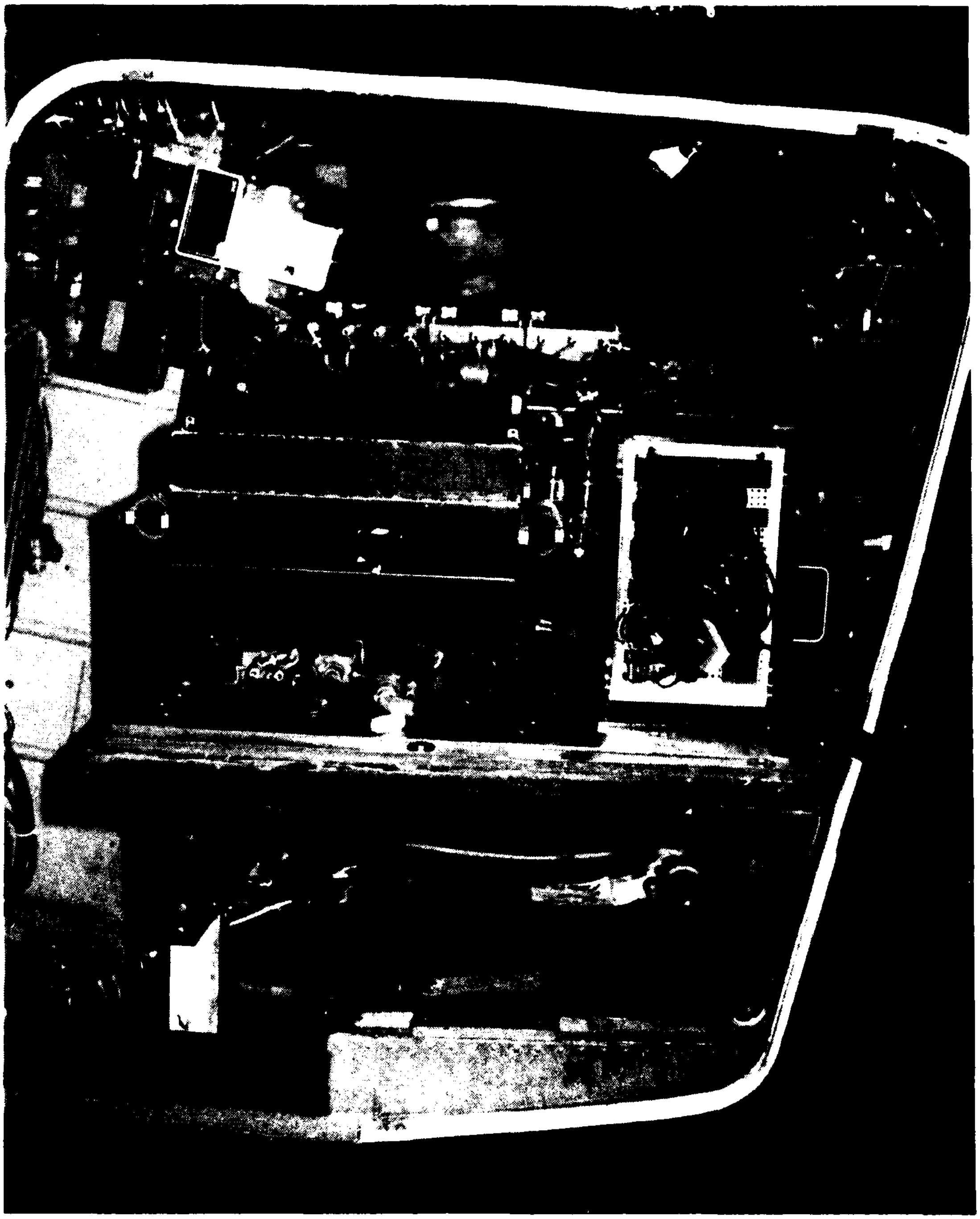


Photo 5. Magnetic Tape Instrumentation System Installation

Main rotor mast torque
Tail rotor mast torque
Tailboom lateral bending at station 220
Tail rotor blade angle
Radar altimeter
Pilot event
Power turbine output speed - N_P
Engine turbine outlet temperature (TOT)

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

GENERAL

1. Conventional test techniques were used in both the performance and handling qualities tests. Detailed descriptions of all test techniques are contained in references 11 and 12, appendix A. The Handling Qualities Rating Scale presented in figure 1 was used to augment pilot comments relative to handling qualities and the Vibration Rating Scale in figure 2 was used to augment the pilot comments relative to vibration.

Aircraft Weight and Balance

2. The aircraft was weighed in the instrumented configuration with full oil and all fuel drained (except trapped fuel) prior to the start of the A&FC program. The initial weight of the aircraft was 2375 pounds with the longitudinal center of gravity (cg) located at FS 117.7. The fuel cell and cockpit fuel gauge were also calibrated. The measured fuel capacity using the gravity fueling method was 71 gallons. The fuel weight for each test flight was determined prior to engine start by using the cockpit fuel gauge.

PERFORMANCE

General

3. Helicopter performance was generalized through the use of nondimensional coefficients as follows.

a. Coefficient of power (C_P):

$$C_P = \frac{SHP \times 550}{\rho A(\Omega R)^3} \tag{1}$$

b. Coefficient of thrust (C_T):

$$C_T = \frac{GW}{\rho A(\Omega R)^2} \tag{2}$$

Where:

SHP = Engine output shaft horsepower
A = Main rotor disc area = 966.5 ft^2

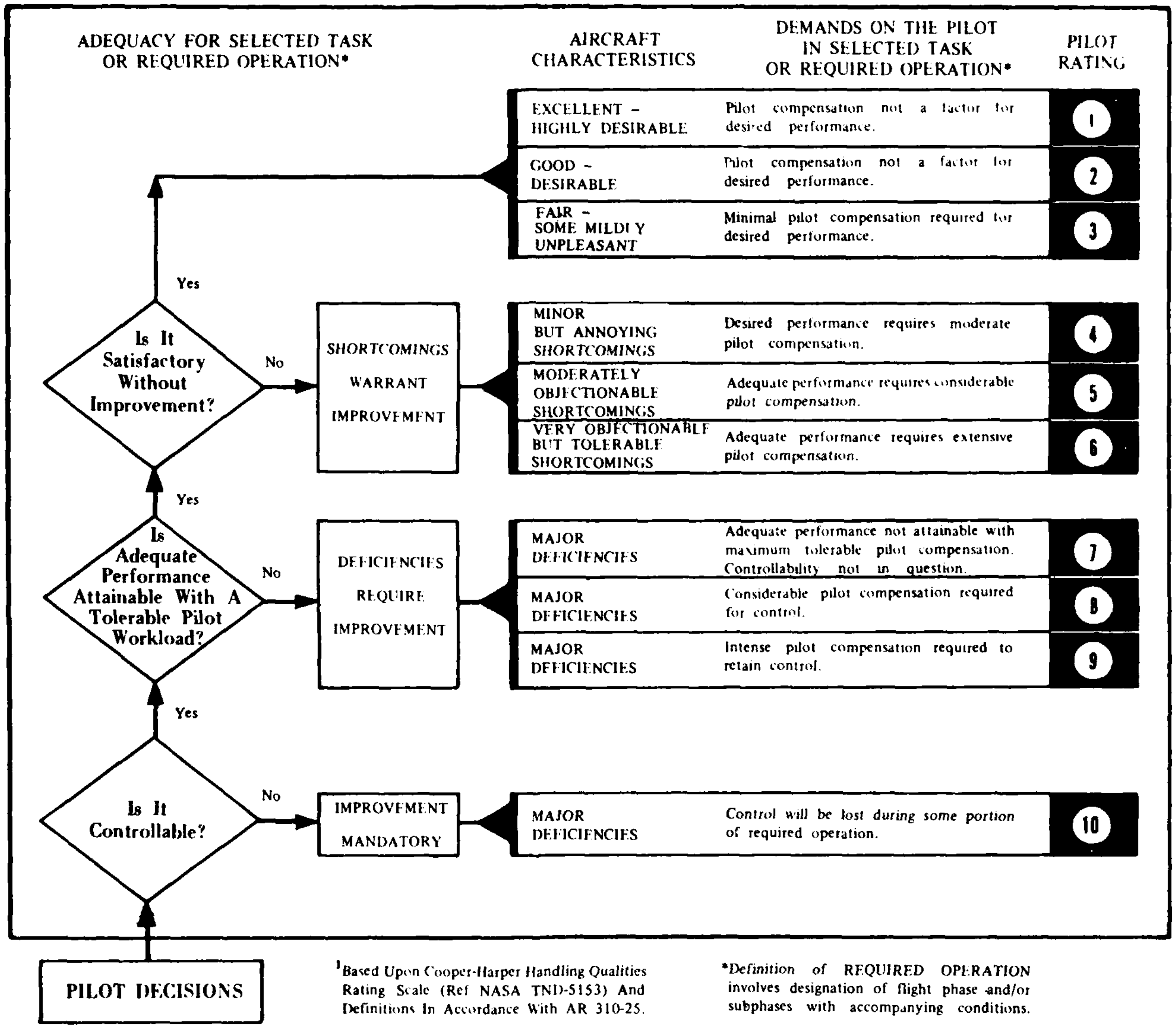


Figure 1. Handling Qualities Rating Scale

DEGREE OF VIBRATION	DESCRIPTION[1]	PILOT RATING
No vibration		0
Slight	Not apparent to experienced aircrew fully occupied by their tasks, but noticeable if their attention is directed to it or if not otherwise occupied.	1 2 3
Moderate	Experienced aircrew are aware of the vibration but it does not affect their work, at least over a short period.	4 5 6
Severe	Vibration is immediately apparent to experienced aircrew even when fully occupied. Performance of primary task is affected or tasks can only be done with difficulty.	7 8 9
Intolerable	Sole preoccupation of aircrew is to reduce vibration level.	10

[1] Based upon the Subjective Vibration Assessment Scale developed by the Aeroplane and Armament Experimental Establishment, Boscombe Down, England.

Figure 2. Vibration Rating Scale

Ω = Main rotor angular velocity (radians/sec)
R = Main rotor radius = 17.54 ft
GW = Gross weight (lb)
ρ = Ambient air density ($lb\text{-}sec^2/ft^4$)

At the normal operating rotor speed of 354 rpm, the following may be used to calculate C_P and C_T:

ΩR = 650.22
$(\Omega R)^2$ = 422,788.28
$(\Omega R)^3$ = 274,906,118.9

Shaft Horsepower Required

4. The engine output shaft torque was determined from the engine manufacturer's torque system. The relationship of measured torque pressure (psi) to engine output torque (ft-lb) was determined from the engine manufacturer's engine calibration (green run sheet). The output shp was determined from the engine output shaft torque and rotational speed by the following equation:

$$SHP = \frac{2\pi \times N_p \times Q}{33000} \qquad (3)$$

where:

N_p = Engine output shaft rotational speed (rpm)
Q = Engine output shaft torque (ft-lb)
33000 = Conversion factor (ft-lb/min/SHP)

5. Figure 3 is presented to show that the measured sum of main and tail rotor power versus the total engine power of the OH-58C does not show any discontinuities. The power loss due to transmission, gear boxes, and any other associated items was approximately 6 percent of the engine power.

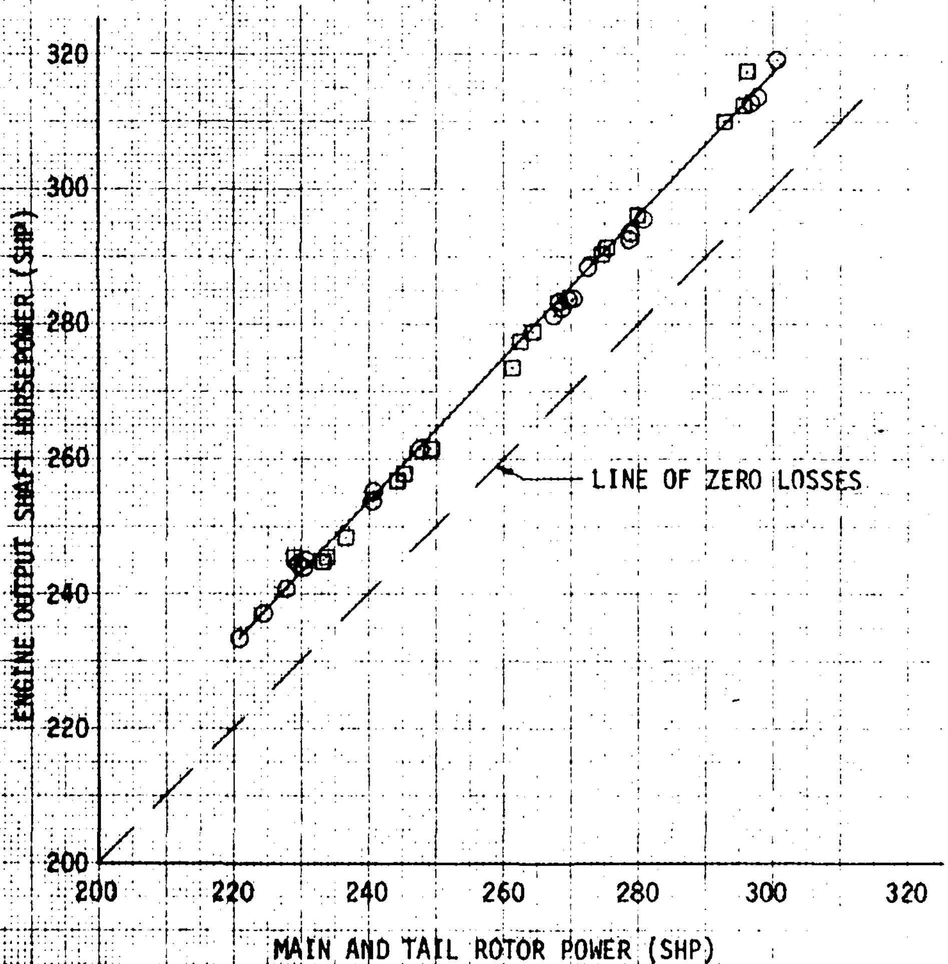
Hover

Hover Performance:

6. Hover performance was obtained out-of-ground effect (OGE) by the free flight hover technique. All hover tests were conducted in winds of less than 3 knots. Atmospheric pressure and temperature were recorded from the aircraft's cockpit instruments and wind conditions were recorded from the ground station. Free

FIGURE 3
ENGINE POWER VERSUS ROTOR POWER
OH-58C USA S/N 68-16850

NOTES: 1. ○ DENOTES STANDARD TAIL ROTOR
2. □ DENOTES IMPROVED TAIL ROTOR
3. DATA OBTAINED DURING OGE HOVER



flight hover tests consisted of stabilizing the helicopter at the desired skid height with reference to the radar altimeter. The aircraft initial gross weight was established by maximum power available. Weight was incrementally removed from the aircraft until the minimum gross weight was obtained. All hover data were reduced to nondimensional parameters of C_P and C_T (equation 1 and 2, respectively).

Tail Rotor Performance:

7. Tail rotor mast torque and directional control positions were used to determine tail rotor horsepower and directional control margins. Terms in equations 1 and 2 which apply to the main rotor were replaced by tail rotor parameters for nondimensionalized tail rotor performance. Since the test required two tail rotors of different diameters, the nondimensional parameters were reduced to dimensional parameters for comparing the test results. Anti-torque system output shaft torque was measured at the ouput shaft of the tail rotor gearbox. Tail rotor shaft horsepower was determined from the following equation.

$$SHP_{TR} \quad \frac{(2\pi)\left(\frac{N_P}{2.3525}\right)(Q_{TR})}{33000} \qquad (4)$$

where:

Q_{TR} = Tail rotor ouput shaft torque (ft-lb)
2.3525 = Gear ratio of engine to tail rotor drive shaft

$$C_{P_{TR}} = \frac{SHP_{TR} \times 550}{\rho A_{TR}(\Omega R)^3_{TR}} \qquad (5)$$

$$C_T \quad \frac{THRUST_{TR}}{\rho A_{TR}(\Omega R)^2_{TR}} \qquad (6)$$

where:

SHP_{TR} = Tail rotor shaft horsepower

A_{TR} = Tail rotor disc area = 20.97 ft^2 (standard tail rotor)
= 23.04 ft^2 (improved tail rotor)

$Thrust_{TR}$ = Tail rotor thrust (determined as outlined in para 8) at 100% tail rotor speed (2627 rpm)

ΩR = 710.67 standard tail rotor
ΩR = 745.06 improved tail rotor

8. The component of tail rotor thrust necessary for stabilized hover was determined by making two assumptions. These assumptions were necessary since tail rotor thrust could not be measured directly during the evaluation. The first assumption was that all directional moments to maintain stabilized hover were generated by the anti-torque tail rotor. This assumption neglected any directional moments generated by rotor downwash and recirculating airflow over the fuselage, tail boom, and empennage. The second assumption was that the temperature of the air passing through the tail rotor was not influenced by the engine exhaust gas. The restoring component of tail rotor thrust was determined from the following equation.

$$Thrust_{TR} = \frac{Q_{MR}}{L_T} \qquad (6)$$

where:

Q_{MR} = Main rotor shaft torque (ft-lb)
L_T = Perpendicular distance between center line of main rotor and tail rotor shafts = 19.55 ft

HANDLING QUALITIES

General

9. Conventional test techniques were used in the evaluation. Detailed descriptions of all test techniques are contained in reference 11, appendix A.

CONTROL SYSTEM CHARACTERISTICS

10. These tests were conducted on the ground with hydraulic and electrical power provided by ground power units. A hand-held force gauge was used to measure the force required to move the cyclic control in incremental displacements to the limits of travel in four directions. Hysteresis was checked by taking measurements in the increasing and decreasing force directions.

The force gauge was also used to measure the force required to move the directional and the collective controls in incremental displacements to the limits of travel in both directions.

CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT

11. These tests were accomplished by establishing a trim condition (airspeed/power combination) with zero control forces at each airspeed.

STATIC LATERAL-DIRECTIONAL STABILITY

12. These tests were accomplished by trimming the aircraft in coordinated flight at the desired conditions. With collective control fixed, the aircraft was then stabilized at incremental sideslip angles up to limit sideslip on both sides of trim while maintaining steady heading at the trimmed airspeed.

MANEUVERING STABILITY

13. The variation of longitudinal control position and force with normal acceleration were determined during steady turns, symmetrical pull-ups and push-overs. Each test consisted of incrementally increasing normal acceleration (load factor) while holding collective position constant. Steady turns, in both directions, were accomplished by stabilizing and trimming in level unaccelerated flight at the desired test airspeed. Load factor was increased to the maximum allowable by incrementally increasing bank angle. Zero sideslip, constant airspeed, and fixed collective were maintained during the turn. Rotor speed was not adjusted during the turn except to maintain the rotor speed within the power on limit. Data were gathered within 1000 feet of the specified test altitude.

Load factor was determined by the equation

$$n = \frac{1}{\cos\theta}$$

where θ = angle of bank (deg)

14. The symmetrical pull-up tests were performed by establishing a level unaccelerated flight condition at the target trim airspeed.

All control forces were trimmed to zero. Without changing the trim collective position and rotor speed, the longitudinal control was rapidly displaced aft against a control fixture until the desired normal acceleration was obtained.

Load factor was determined by the equation

$$n = Q \frac{V}{g} + 1$$

where V = aircraft velocity (ft/sec)
Q = aircraft pitch rate (radians/sec)
g = acceleration of gravity 32.1735 ft/sec^2

15. The symmetrical push-over tests were performed by establishing a level unaccelerated flight condition. All control forces were trimmed to zero. While maintaining the trim collective position and rotor speed, the longitudinal control was rapidly displaced forward against a control fixture until the desired normal acceleration was obtained. The pull-up and push-over tests were continued for increasing step inputs until the desired normal acceleration range was reached.

DYNAMIC STABILITY

16. These tests consisted of evaluating both the short-term and long-term responses of the aircraft. The tests were performed with the stability augmentation system activated. Short-term testing was accomplished by forward and aft longitudinal control pulse inputs. The pulse input was obtained by rapidly displacing the control approximately 1 inch, holding for 0.5 second, then rapidly returning to the trim position and holding until aircraft motions were damped. All other controls other than the input control remained fixed during the test. Long-term longitudinal characteristics were evaluated by displacing the aircraft from the trim airspeed approximately 10 knots. Starting at airspeeds both slower and faster than the trim airspeed were accomplished. The slower airspeed start technique consisted of reducing airspeed below the trim value using cyclic control, then returning the cyclic control to its original trim position using a control fixture and observing the resulting aircraft response. The faster airspeed start technique was similar except that airspeed was increased above the original trim value.

CONTROLLABILITY

17. The tests were accomplished by applying longitudinal, lateral and directional step inputs of up to at least 1 inch in both directions. The step input was made by rapidly displacing the control from trim, against a control fixture. The input was rigidly held until a steady rate was obtained or recovery was necessary. A build-up of increasing step displacement was conducted. All controls other than the input control remained fixed. In forward flight the inputs were initiated during unaccelerated zero sideslip level flight. The hover tests were conducted in winds of 5 knots or less at a skid height of 50 feet. The sideward flight tests were conducted in winds of 5 knots or less at a skid height of 10 feet.

LOW-SPEED FLIGHT CHARACTERISTICS

18. Testing was accomplished using the ground pace vehicle method in winds of 5 knots or less. Tests were flown in 5 knot increments from a hover to 40 knots forward and right sideward and 35 knots left sideward and rearward unless limited by adverse performance or degraded handling qualities. All tests were conducted by stabilizing at a skid height of 10 feet. The pace vehicle then established the desired speed using a calibrated fifth wheel or speedometer for a reference ground speed. The test aircraft was flown in formation with the pace vehicle utilizing the ground and the aircraft horizontal situation indicator for heading stabilization. Data were recorded when the relative motion between the aircraft and pace vehicle was zero and the radar altimeter indicated no vertical displacement from the desired skid height.

SIMULATED ENGINE FAILURE

19. These tests were conducted by first stabilizing the aircraft at the desired trim flight condition and then simulating engine failure by rapidly reducing the throttle to engine idle. Controls were held fixed for 2 seconds after the power reduction or until the recovery was necessary. The aircraft was then stabilized in autorotational descent. These tests were conducted with the stability augmentation system on and off.

APPENDIX E. TEST DATA

INDEX

FIGURE 1
HOVER PERFORMANCE
OH-58C USA S/N 68-16850
SKID HEIGHT = 50 FEET

SYMBOL	AVG ROTOR SPEED (RPM)	AVG DENSITY ALTITUDE (FT)	AVG OAT (° C)	TAIL ROTOR CONFIGURATION
○	346.0	8400	10.5	STANDARD TAIL ROTOR
□	354.0	8450	11.0	STANDARD TAIL ROTOR
△	359.0	8450	11.0	STANDARD TAIL ROTOR
●	347.0	8780	14.5	IMPROVED TAIL ROTOR
■	354.0	8840	15.0	IMPROVED TAIL ROTOR
▲	358.0	8840	15.0	IMPROVED TAIL ROTOR

NOTES: 1. SKID HEIGHT DETERMINED BY RADAR ALTIMETER
2. WINDS LESS THAN 3 KNOTS
3. FREE FLIGHT HOVER TECHNIQUE

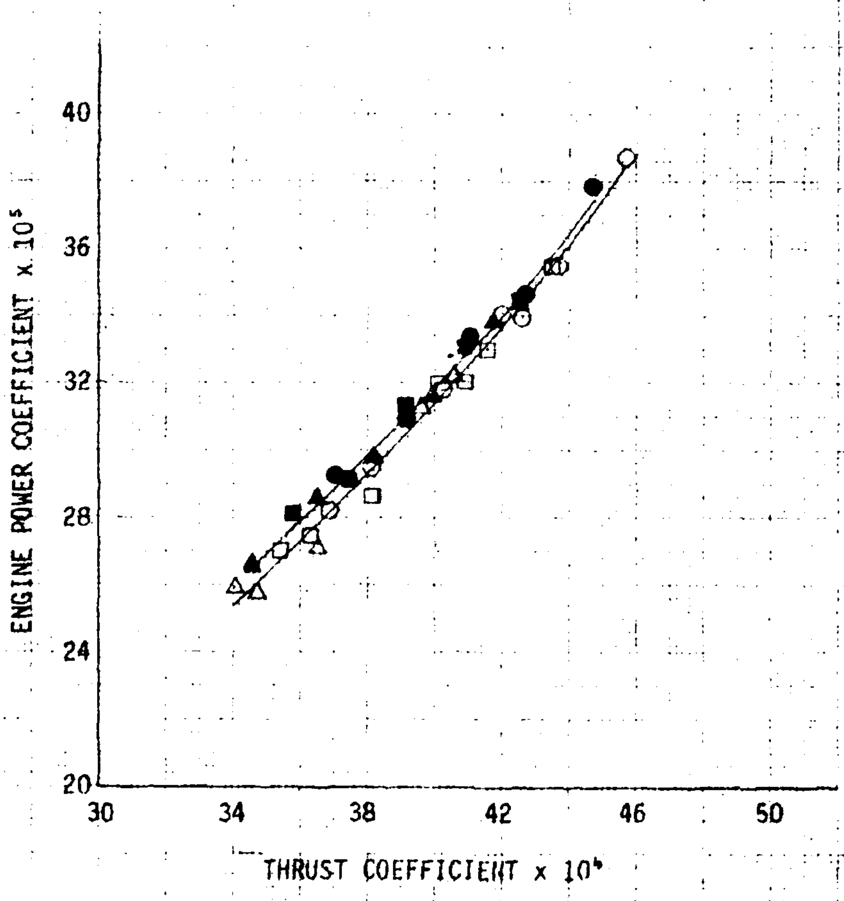


FIGURE 2
HOVER PERFORMANCE COMPARISON
OH-58C USA S/N 68-16850
SKID HEIGHT = 50 FEET

ROTOR SPEED (RPM)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	MAIN ROTOR DIAMETER (FT)
354	8900	15	35.08

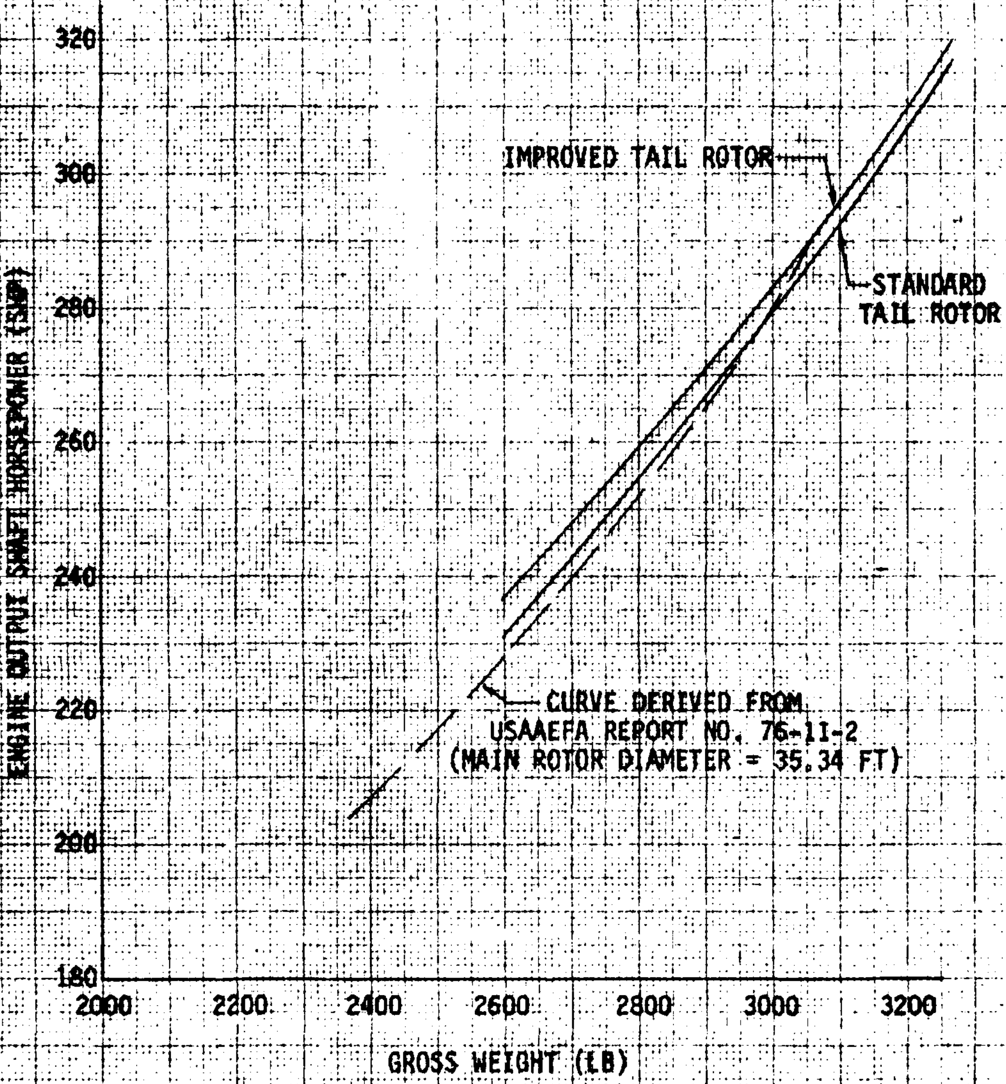


FIGURE 8
TAIL ROTOR HOVER PERFORMANCE
OH-58C USA S/N 68-16850
SKID HEIGHT = 50 FEET

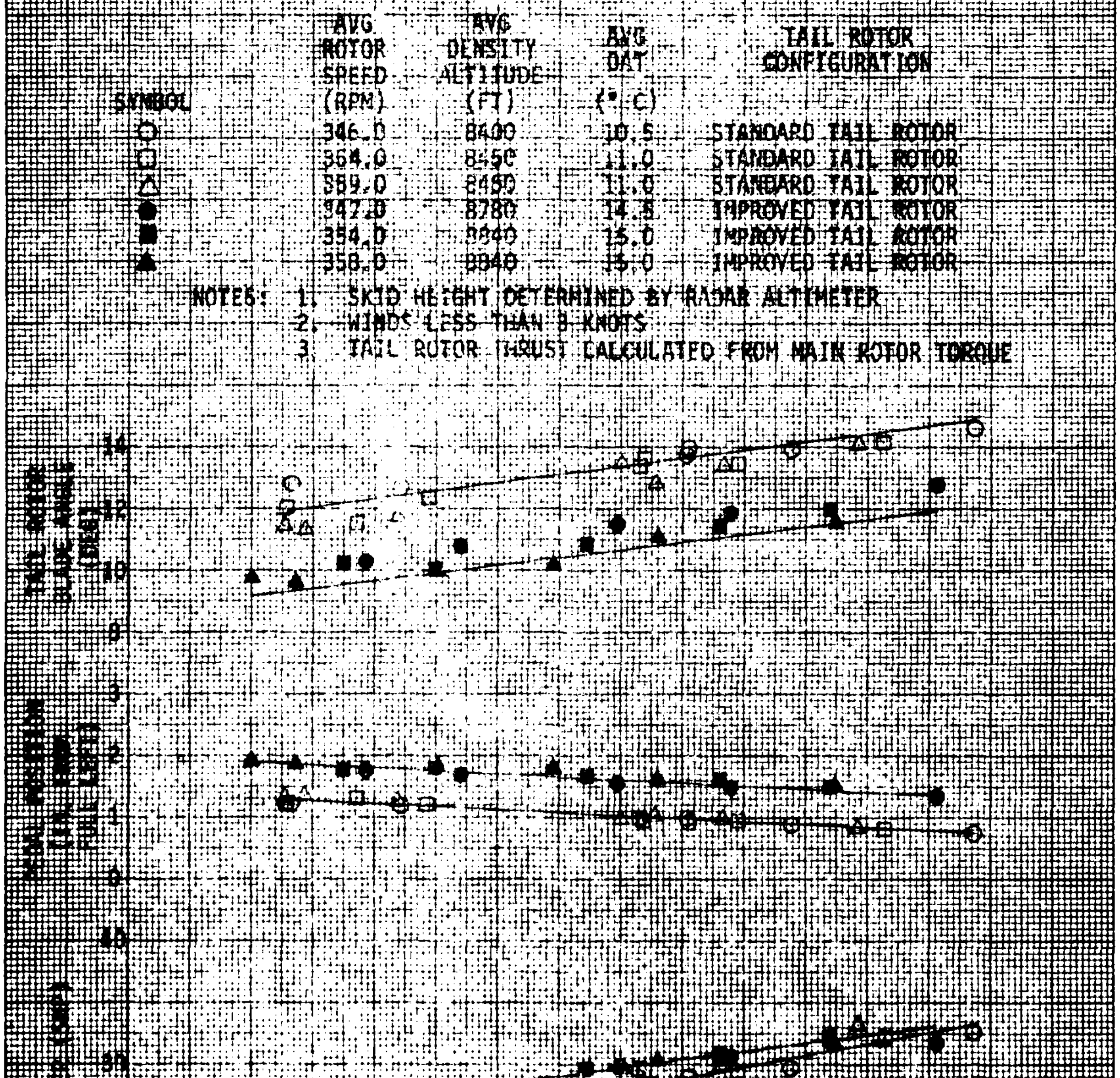


FIGURE 4

REFERRED TAIL ROTOR POWER VERSUS REFERRED TAIL ROTOR THRUST

OH-58C USA S/N 68-16850

SYMBOL	AVG ROTOR SPEED (RPM)	AVG DENSITY ALTITUDE (FT)	AVG OAT (° C)	TAIL ROTOR CONFIGURATION
○	346.0	8400	10.5	STANDARD TAIL ROTOR
□	354.0	8450	11.0	STANDARD TAIL ROTOR
△	359.0	8450	11.0	STANDARD TAIL ROTOR
●	347.0	8780	14.5	IMPROVED TAIL ROTOR
■	354.0	8840	15.0	IMPROVED TAIL ROTOR
▲	358.0	8840	15.0	IMPROVED TAIL ROTOR

NOTES:
1. SKID HEIGHT DETERMINED BY RADAR ALTIMETER
2. WINDS LESS THAN 3 KNOTS
3. 50 FT SKID HEIGHT
4. TAIL ROTOR THRUST CALCULATED FROM MAIN ROTOR TORQUE

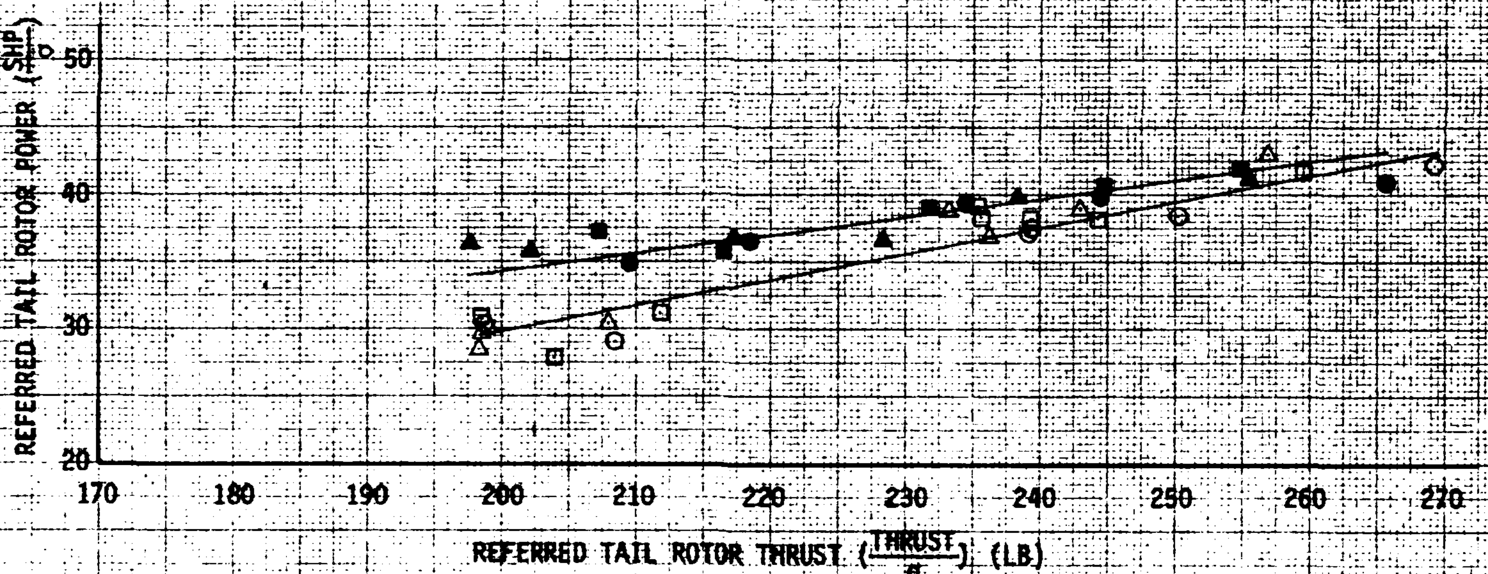


FIGURE 5
LONGITUDINAL CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16850

NOTES:
1. ROTORS STATIC.
2. FORCES AND POSITIONS MEASURED AT CENTER OF GRIP.
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS.
4. BOOST SYSTEM ON.
5. SCAS ON.
6. TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES.
7. LATERAL CONTROL POSITION = 4.8 INCHES FROM FULL LEFT.
8. FORCE TRIM ON, ADJUSTABLE CYCLIC FRICTION OFF.

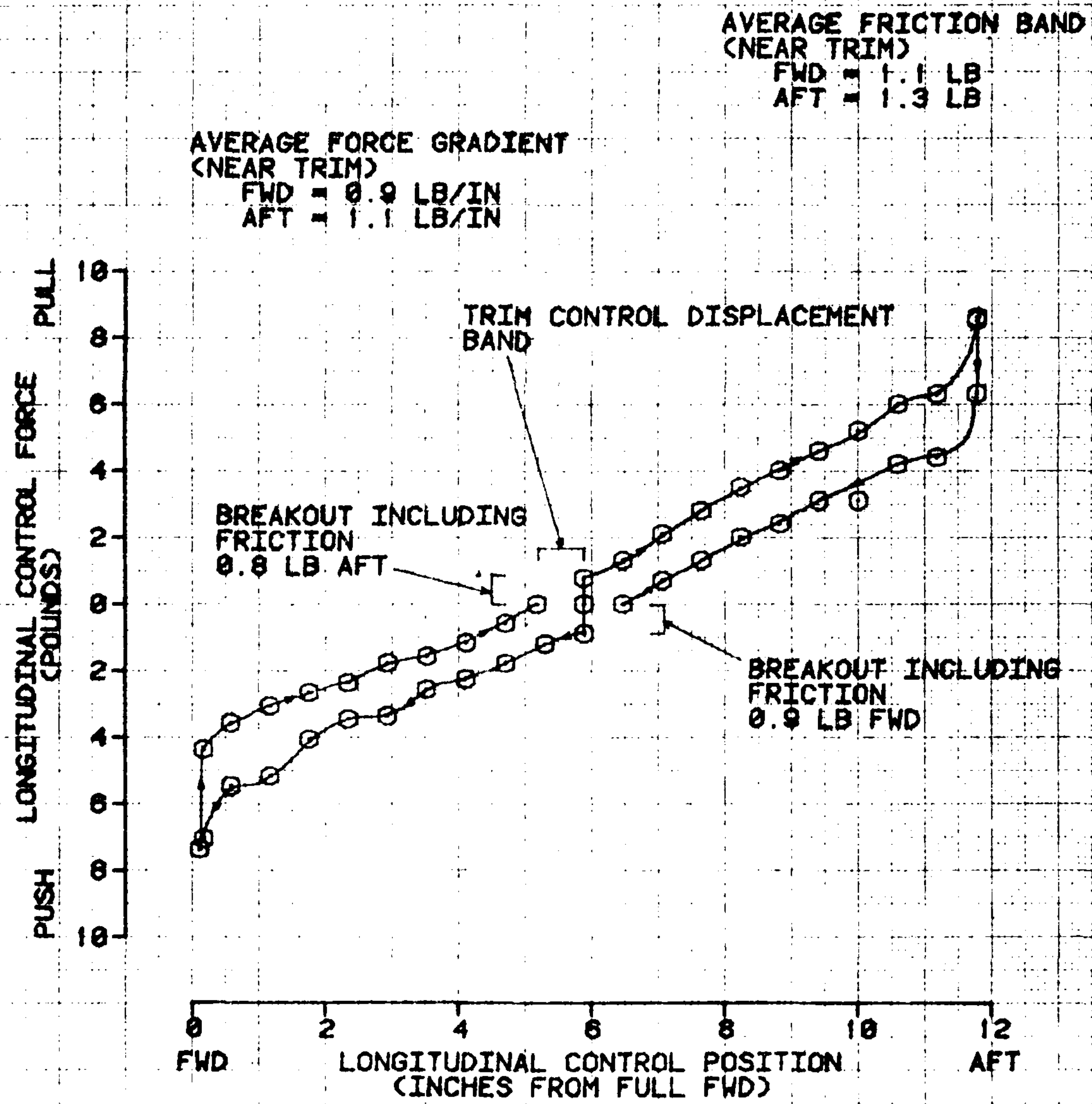


FIGURE 6
LATERAL CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16850

NOTES:
1. ROTORS STATIC.
2. FORCES AND POSITIONS MEASURED AT CENTER OF GRIP.
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS.
4. BOOST SYSTEM ON.
5. SCAS ON.
6. TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES.
7. LONGITUDINAL CONTROL POSITION = 5.9 INCHES FROM FULL FORWARD.
8. FORCE TRIM ON, ADJUSTABLE CYCLIC FRICTION OFF.

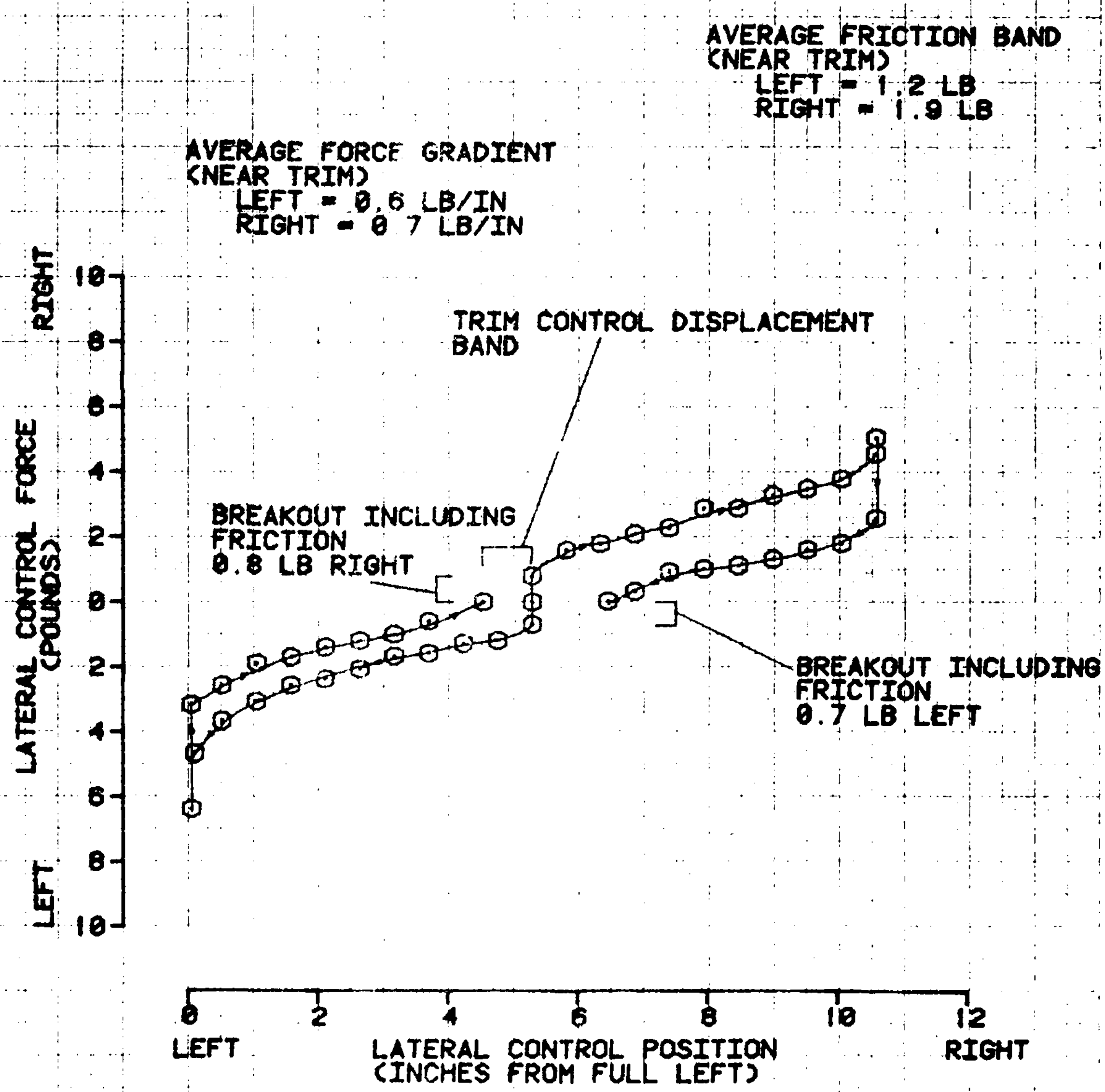


FIGURE 7
DIRECTIONAL CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16850

NOTES:
1. ROTORS STATIC.
2. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS.
3. BOOST SYSTEM ON.
4. SCAS ON.
5. TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES.
6. SOLID SYMBOL DENOTES START POINT

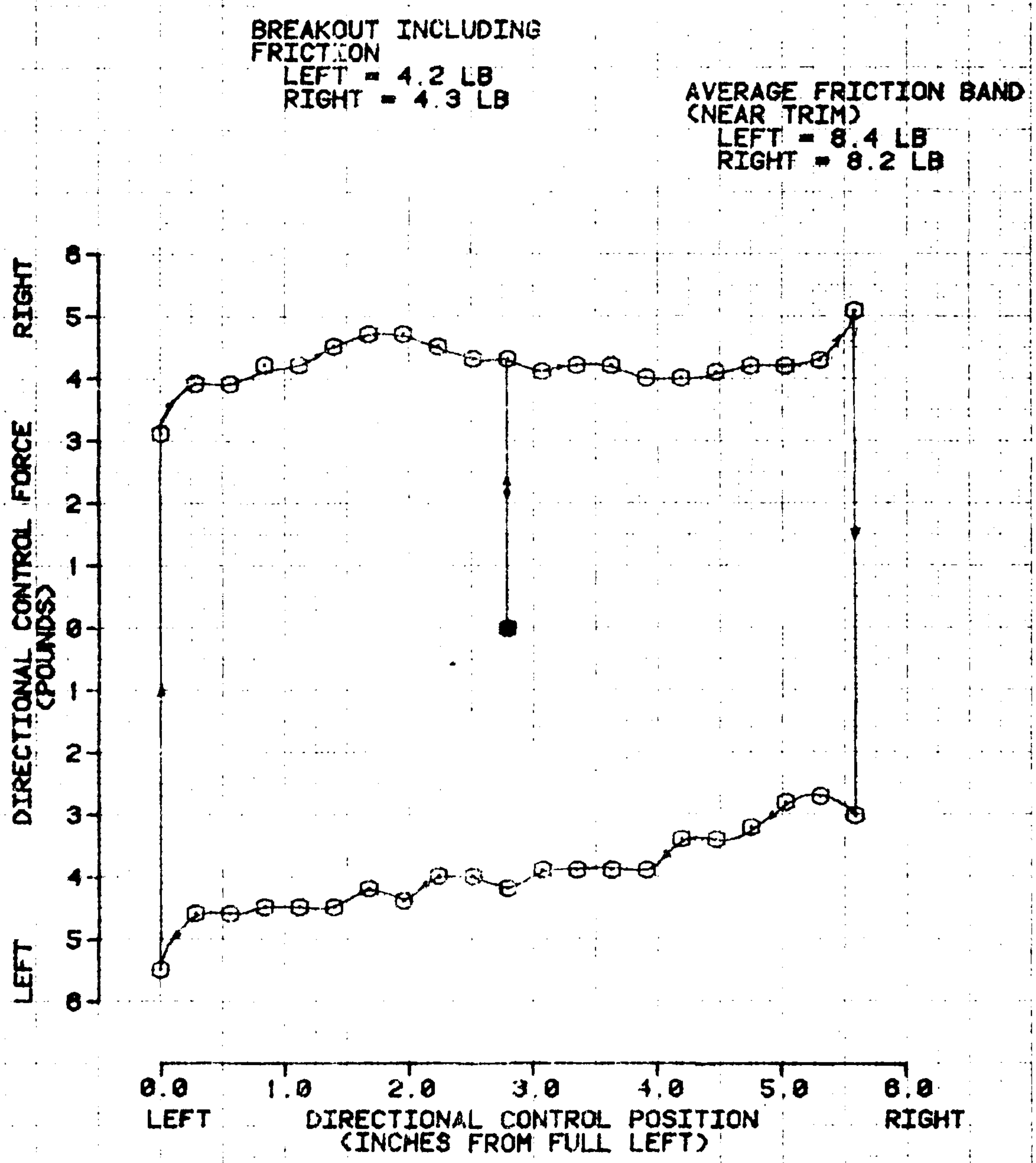
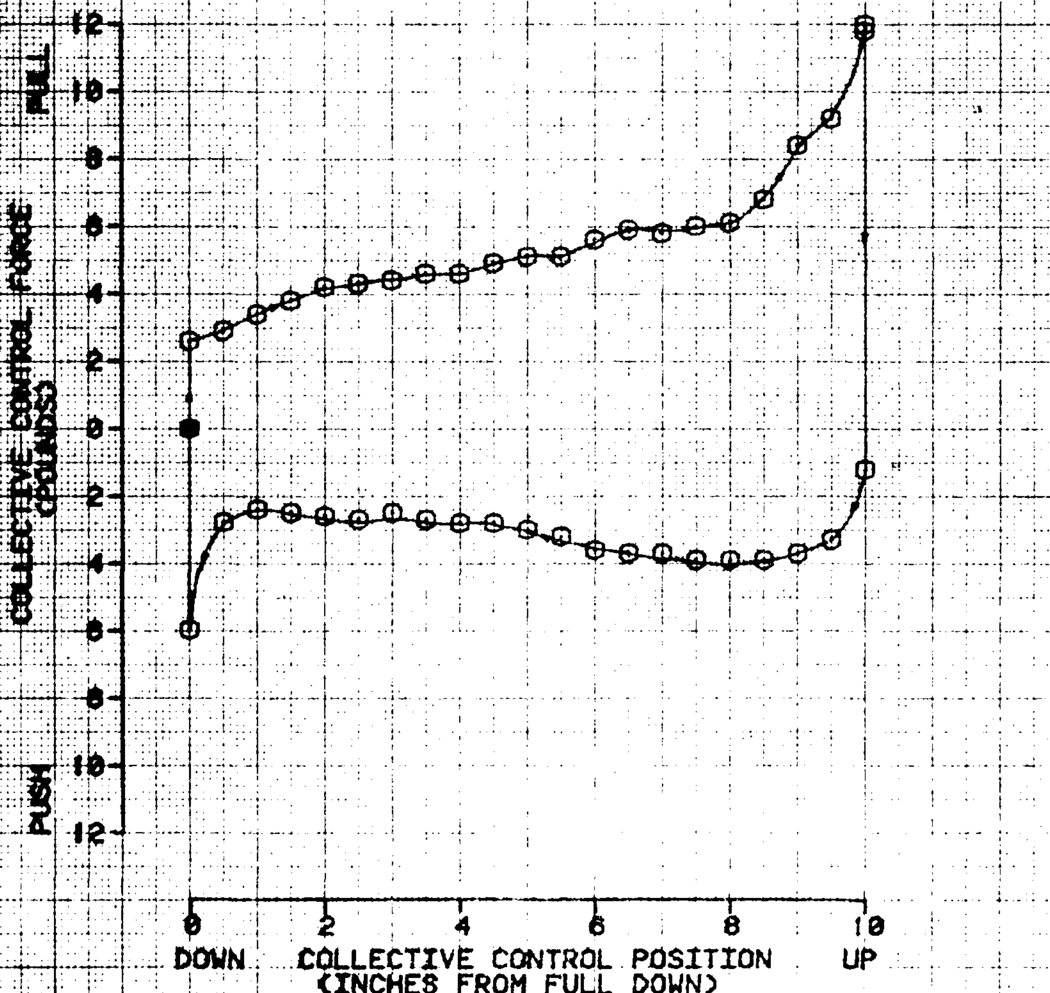


FIGURE 8
COLLECTIVE CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16850

NOTES:
1. ROTORS STATIC.
2. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS.
3. FORCE AND POSITION MEASURED AT CENTER OF GRIP
4. BOOST SYSTEM ON.
5. SCAS ON.
6. TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES.
7. SOLID SYMBOL DENOTES START POINT
8. ADJUSTABLE COLLECTIVE FRICTION OFF



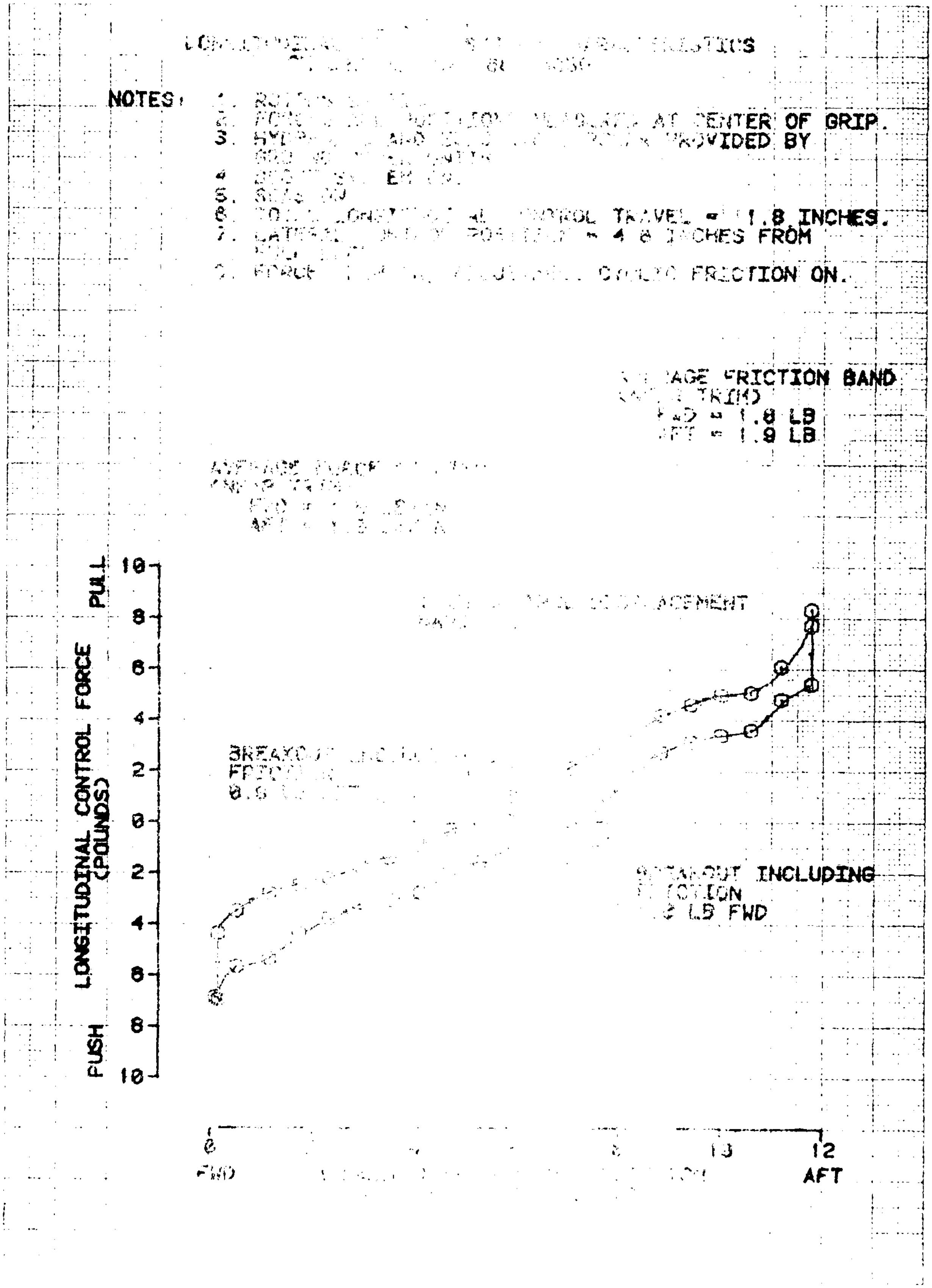

NOTES:
CENTER OF GRIP.
PROVIDED BY
1.8 INCHES.
4.8 INCHES FROM
FRICTION ON.
FRICTION BAND
TRIM)
= 1.8 LB
= 1.9 LB
PULL
LONGITUDINAL CONTROL FORCE
(POUNDS)
PUSH
10
8
6
4
2
0
2
4
6
8
10
ACEMENT
INCLUDING
LB FWD
0
FWD
12
AFT

FIGURE 10
LATERAL CONTROL SYSTEM CHARACTERISTICS
OH-58C USA S/N 68-16850

NOTES:
1. ROTORS STATIC.
2. FORCES AND POSITIONS MEASURED AT CENTER OF GRIP.
3. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS.
4. BOOST SYSTEM ON.
5. SCAS ON.
6. TOTAL LATERAL CONTROL TRAVEL = 10.8 INCHES.
7. LONGITUDINAL CONTROL POSITION = 5.9 INCHES FROM FULL FORWARD.
8. FORCE TRIM ON, ADJUSTABLE CYCLIC FRICTION ON.

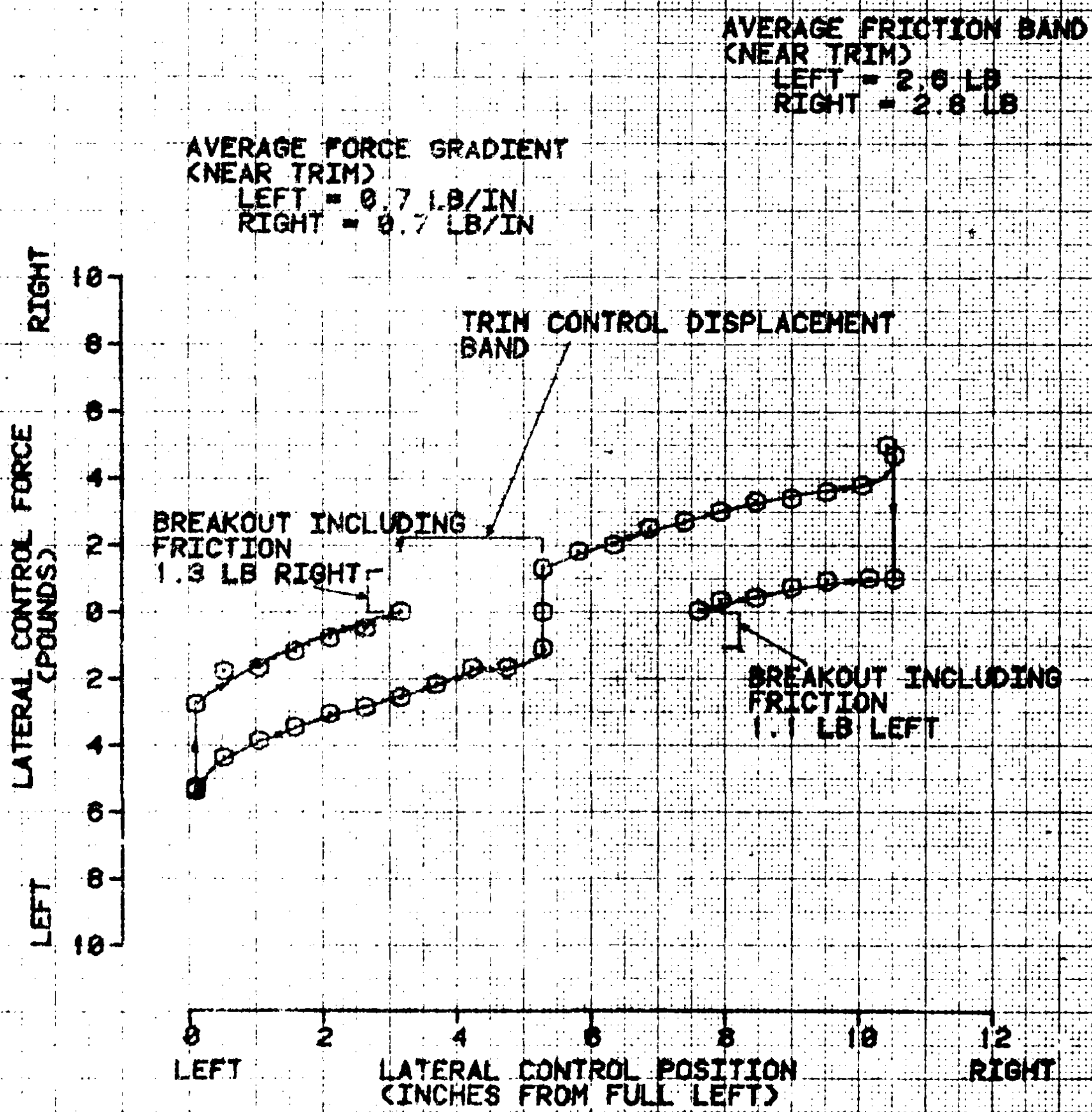


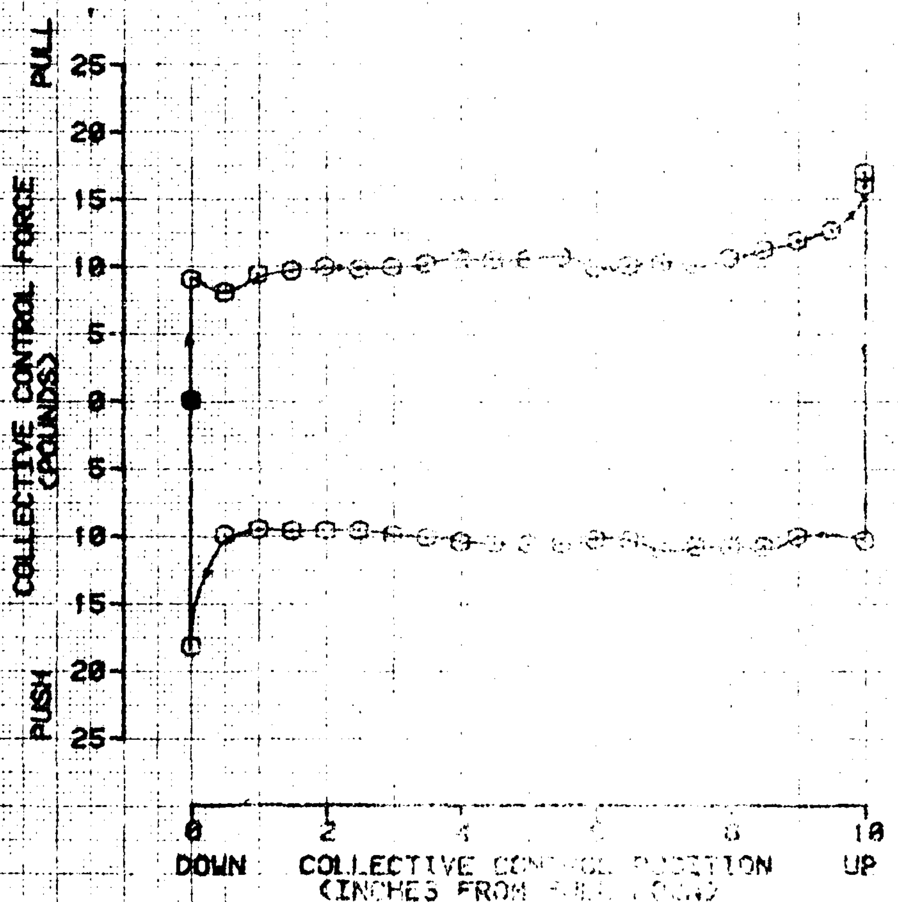
FIGURE 11

COLLECTIVE CONTROL SYSTEM CHARACTERISTICS

OH-58C USA S/N 68-[illegible]

NOTES:

1. ROTORS STATIC
2. HYDRAULIC AND ELECTRICAL POWER PROVIDED BY GROUND POWER UNITS
3. FORCE AND POSITION MEASURED AT CENTER OF GRIP
4. BOOST SYSTEM ON
5. SCAS ON.
6. TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES.
7. SOLID SYMBOL DENOTES START POINT
8. ADJUSTABLE COLLECTIVE FRICTION ON



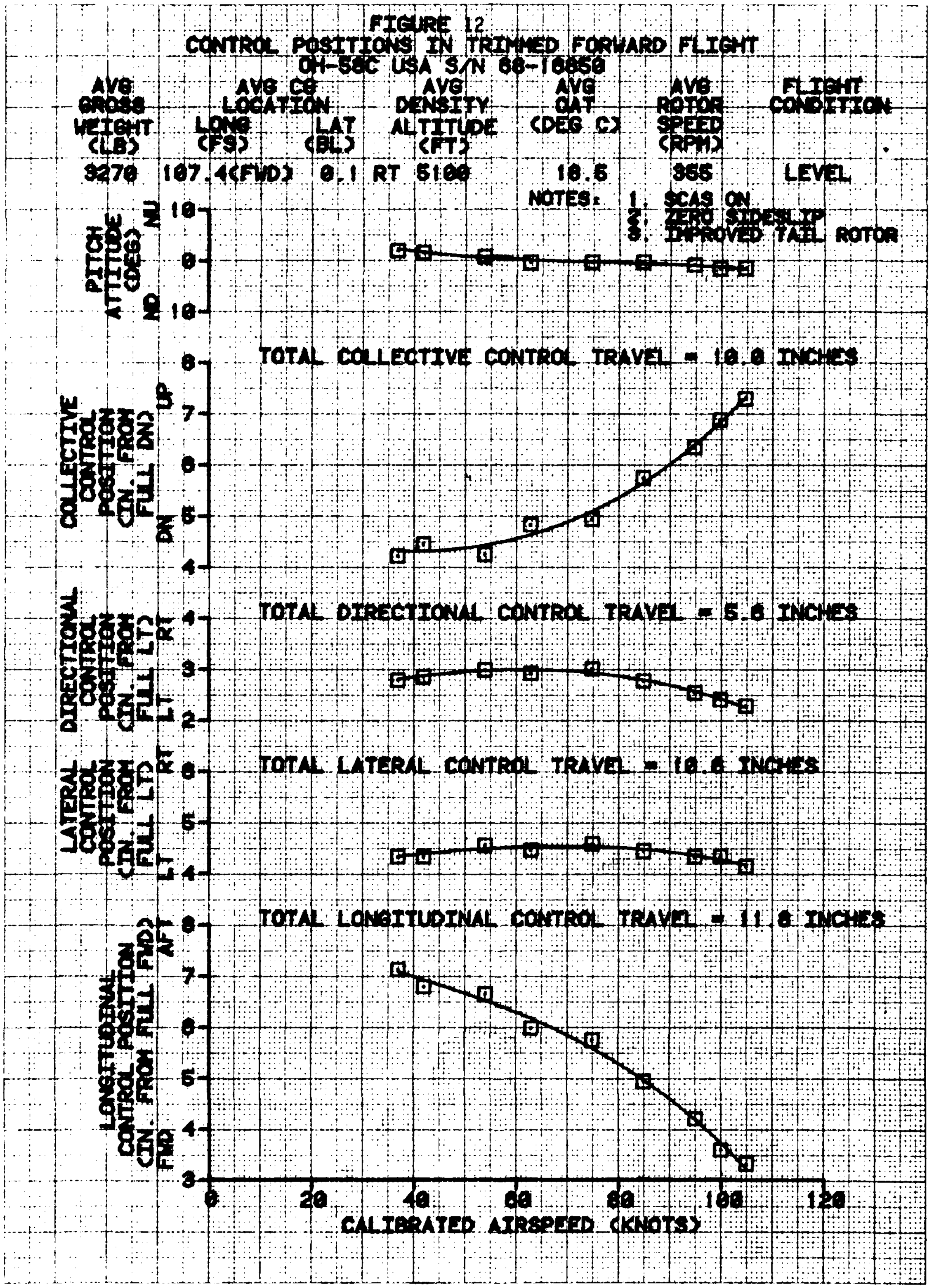


FIGURE 12
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
3270
107.4(FWD)
0.1 RT
5100
18.5
355
LEVEL
NOTES: 1. SCAS ON
2. ZERO SIDESLIP
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG)
NU
ND
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.0 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
CALIBRATED AIRSPEED (KNOTS)

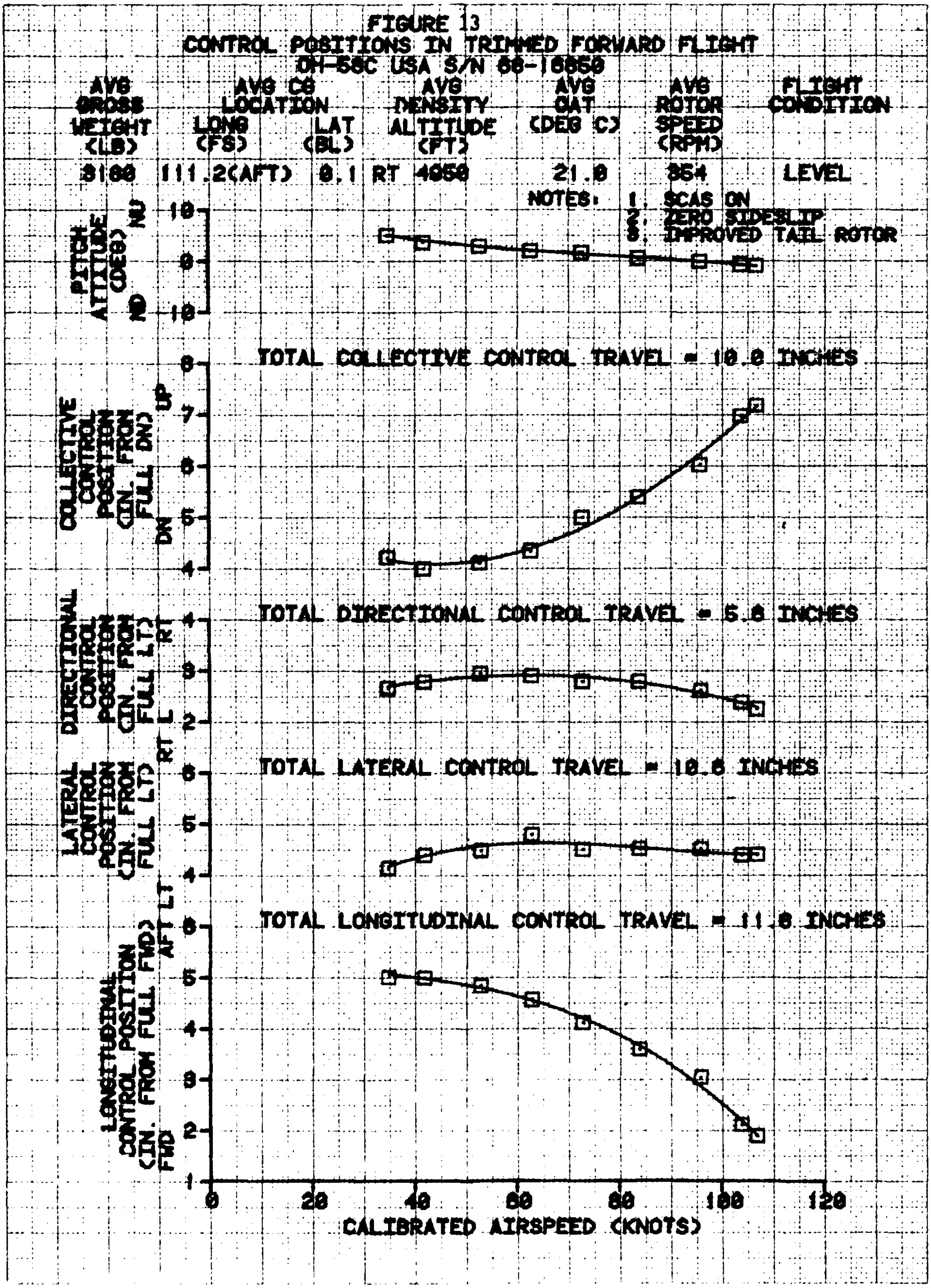


FIGURE 13
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
3100 111.2(AFT) 0.1 RT 4050 21.0 354 LEVEL
NOTES: 1. SCAS ON
2. ZERO SIDESLIP
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG) NU ND
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DN) UP DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT) RT L
TOTAL LATERAL CONTROL TRAVEL = 10.8 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) RT LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD) AFT FWD
CALIBRATED AIRSPEED (KNOTS)

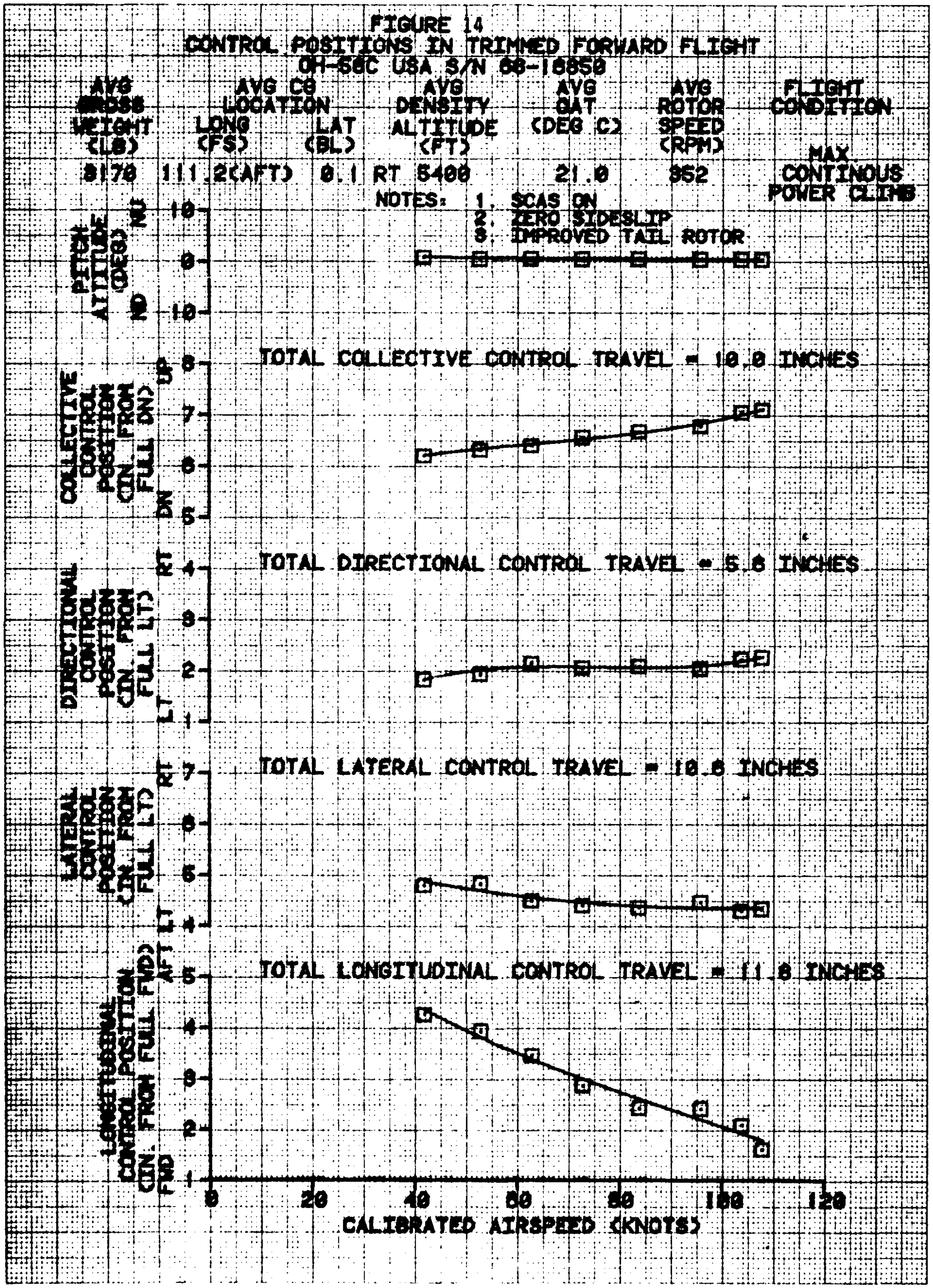
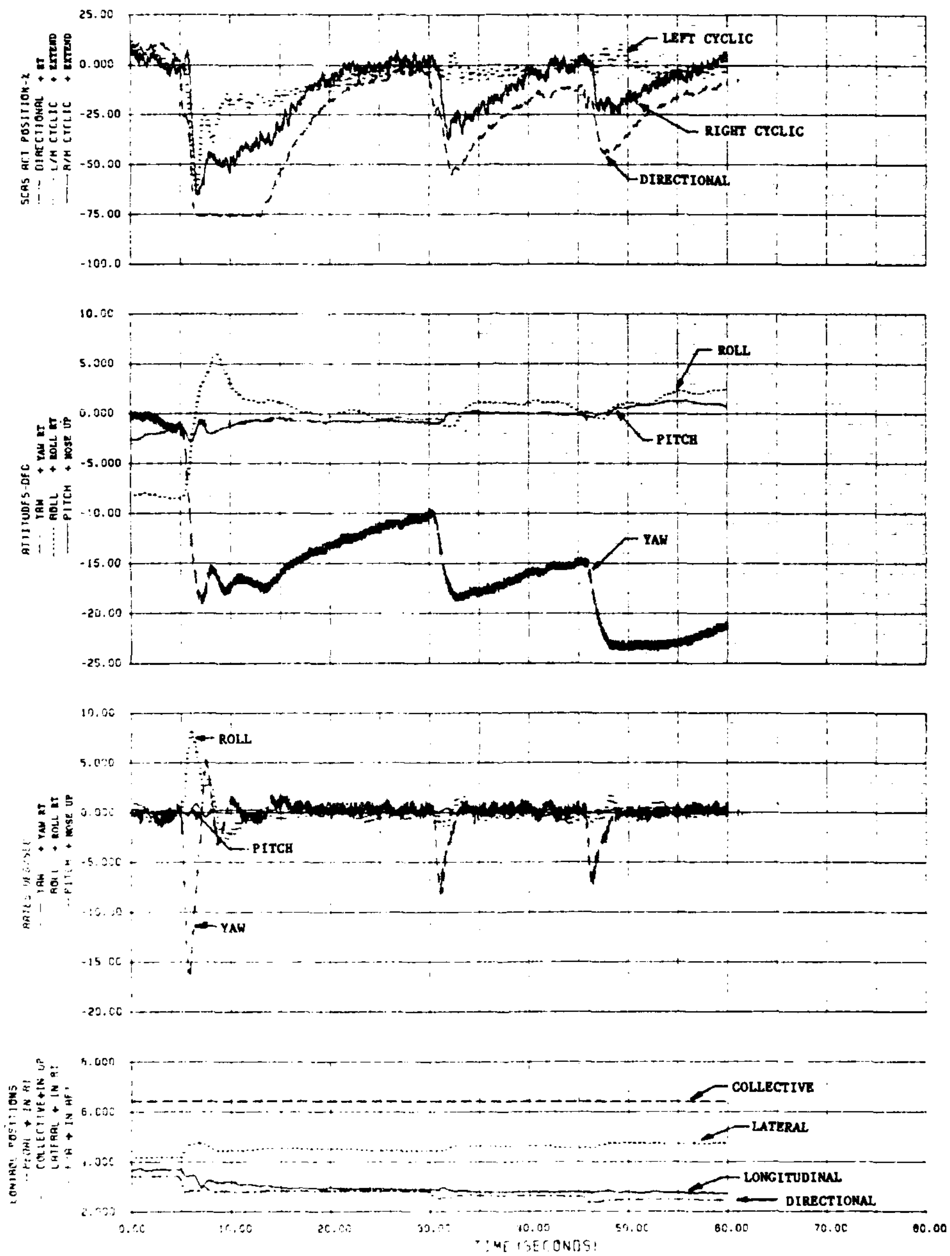


FIGURE 14
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
OH-58C USA S/N 68-16850

FIGURE 15
DIRECTIONAL TRIMMABILITY
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3100	111.8 (AFT)	0.3 RT	6800	19.0	353	89	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR



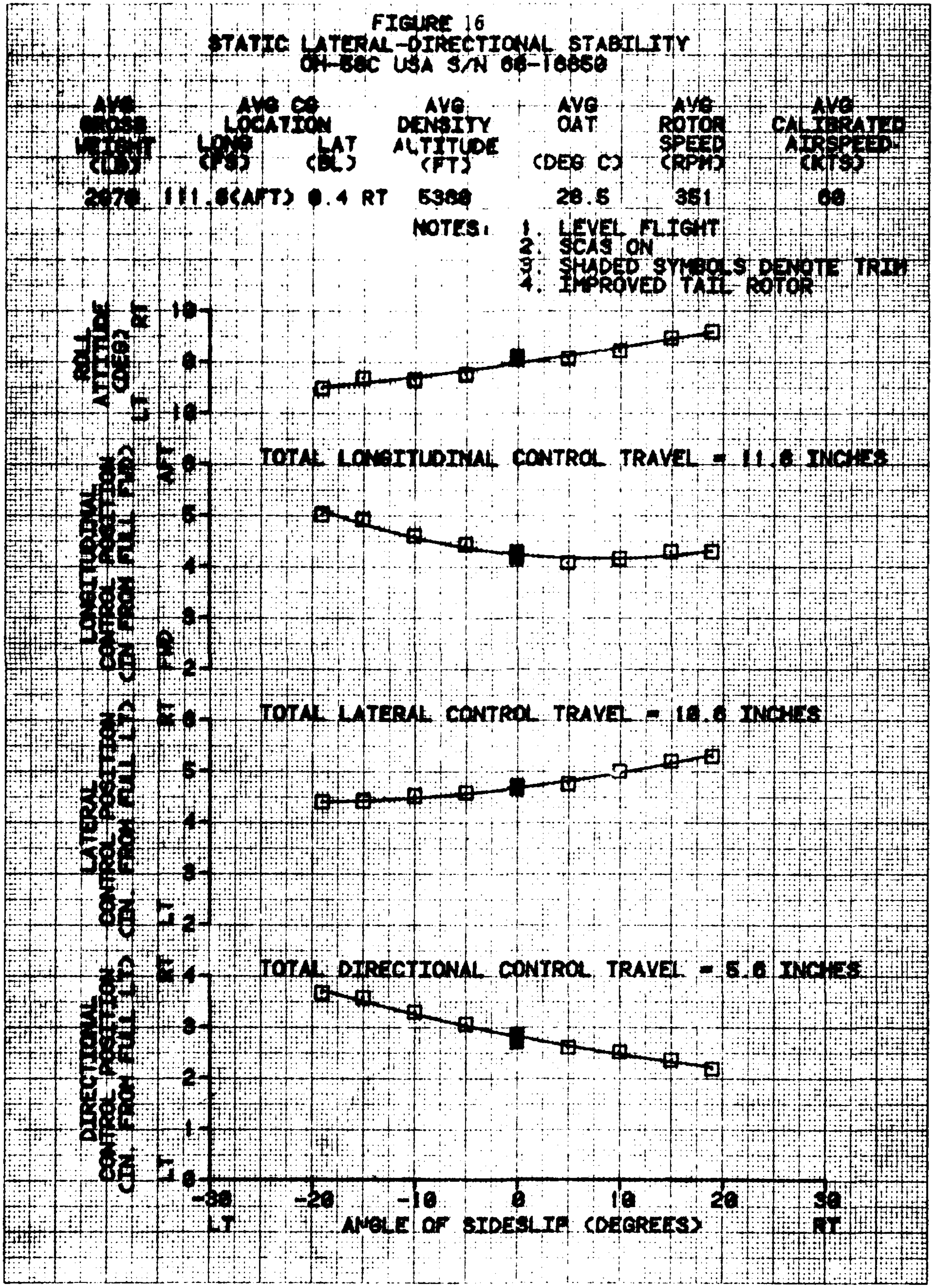


FIGURE 16
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
AVG CALIBRATED AIRSPEED (KTS)
2870
111.8(AFT)
0.4 RT
5300
28.5
351
60
NOTES: 1. LEVEL FLIGHT
2. SCAS ON
3. SHADED SYMBOLS DENOTE TRIM
4. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
TOTAL LATERAL CONTROL TRAVEL = 10.8 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
-30
-20
-10
0
10
20
30
LT
ANGLE OF SIDESLIP (DEGREES)
RT

FIGURE 17
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KTS)
3020	111.8(AFT)	0.4 RT	5250	28.5	350	90

NOTES: 1. LEVEL FLIGHT
2. SCAS ON
3. SHADED SYMBOLS DENOTE TRIM
4. IMPROVED TAIL ROTOR

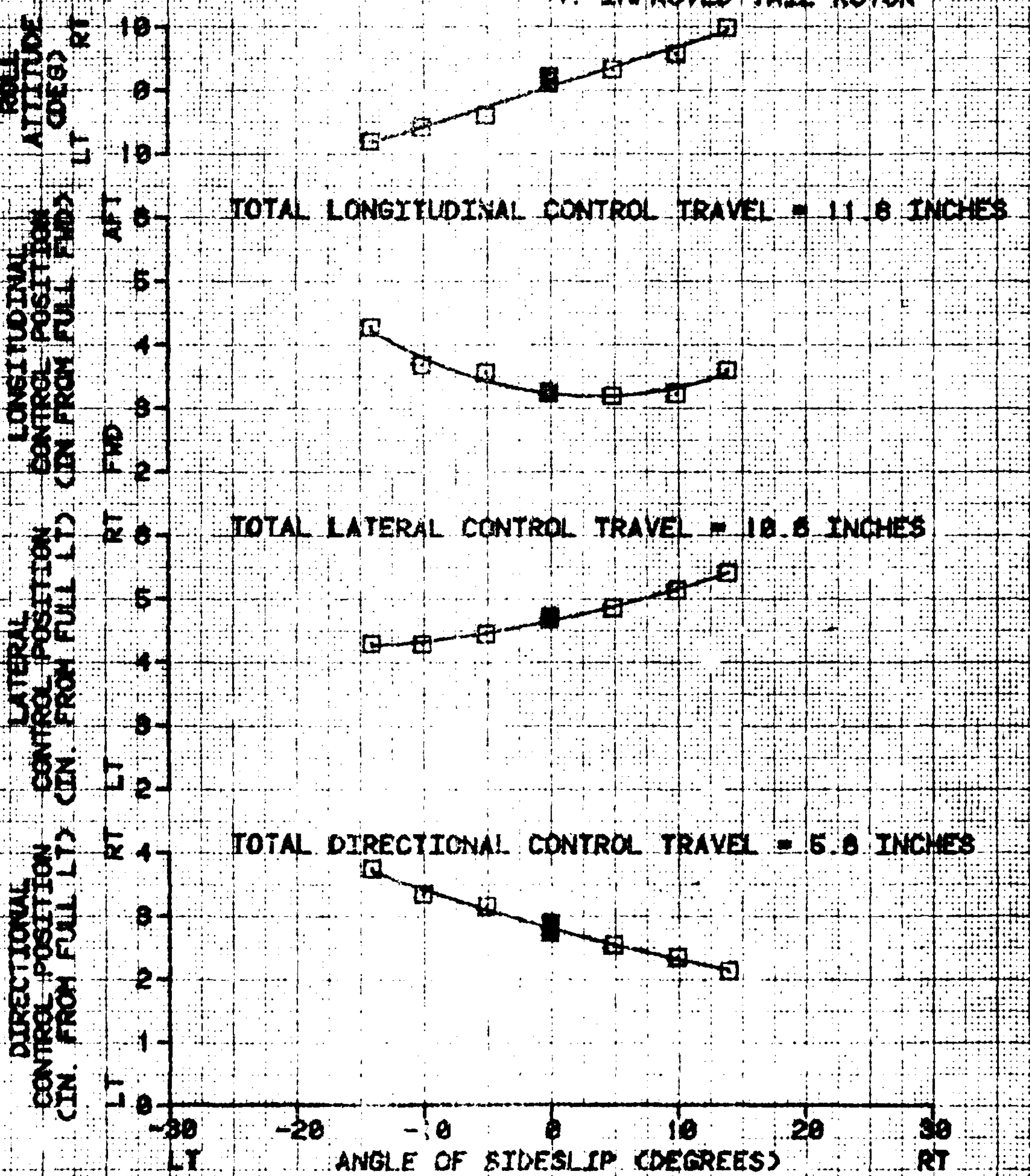


FIGURE 18
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KTS)
2950	111.8(AFT)	0.4 RT	8220	23.5	350	60

NOTES: 1. CLIMBING FLIGHT
2. SCAS ON
3. SHADED SYMBOLS DENOTE TRIM
4. IMPROVED TAIL ROTOR

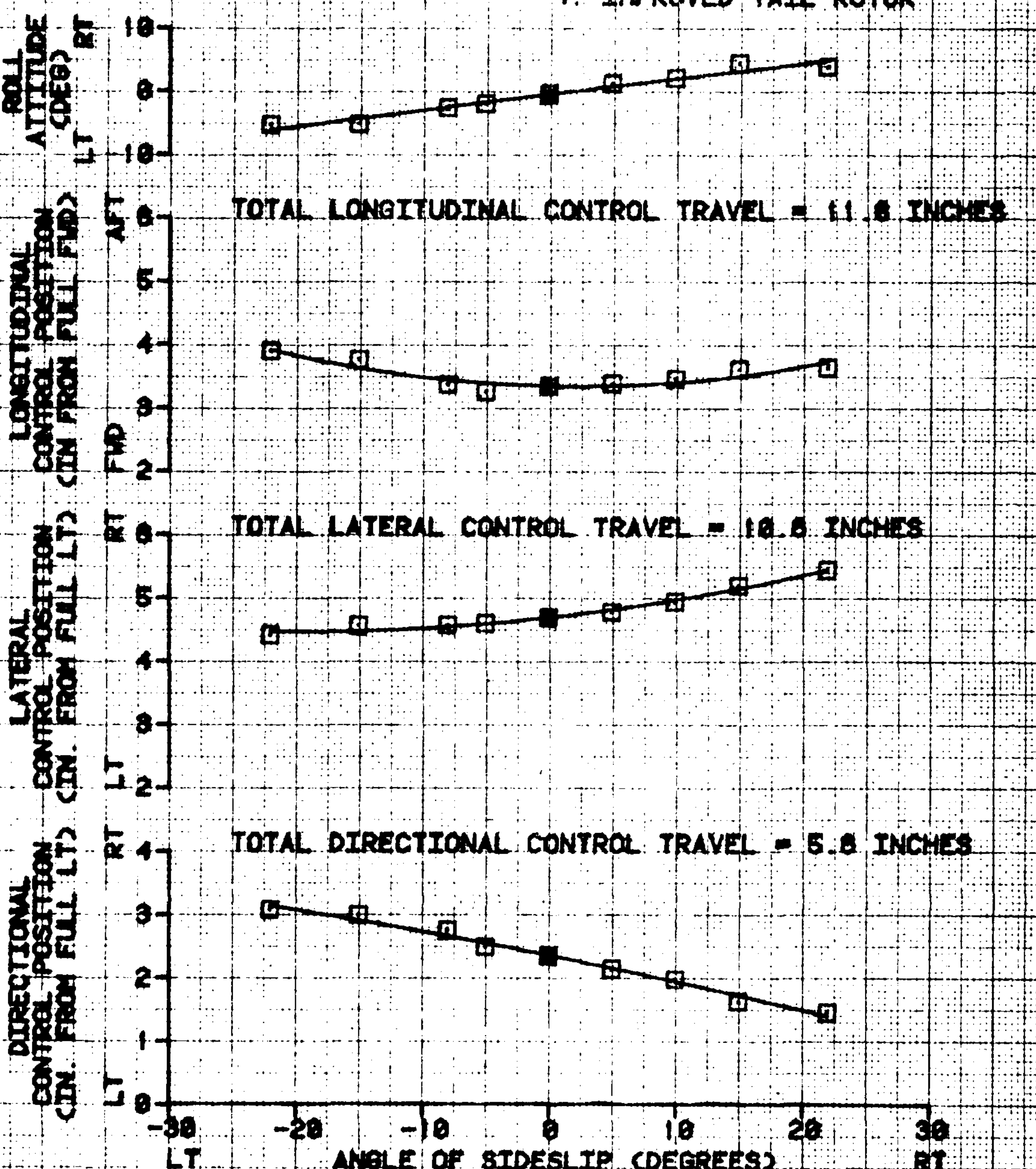
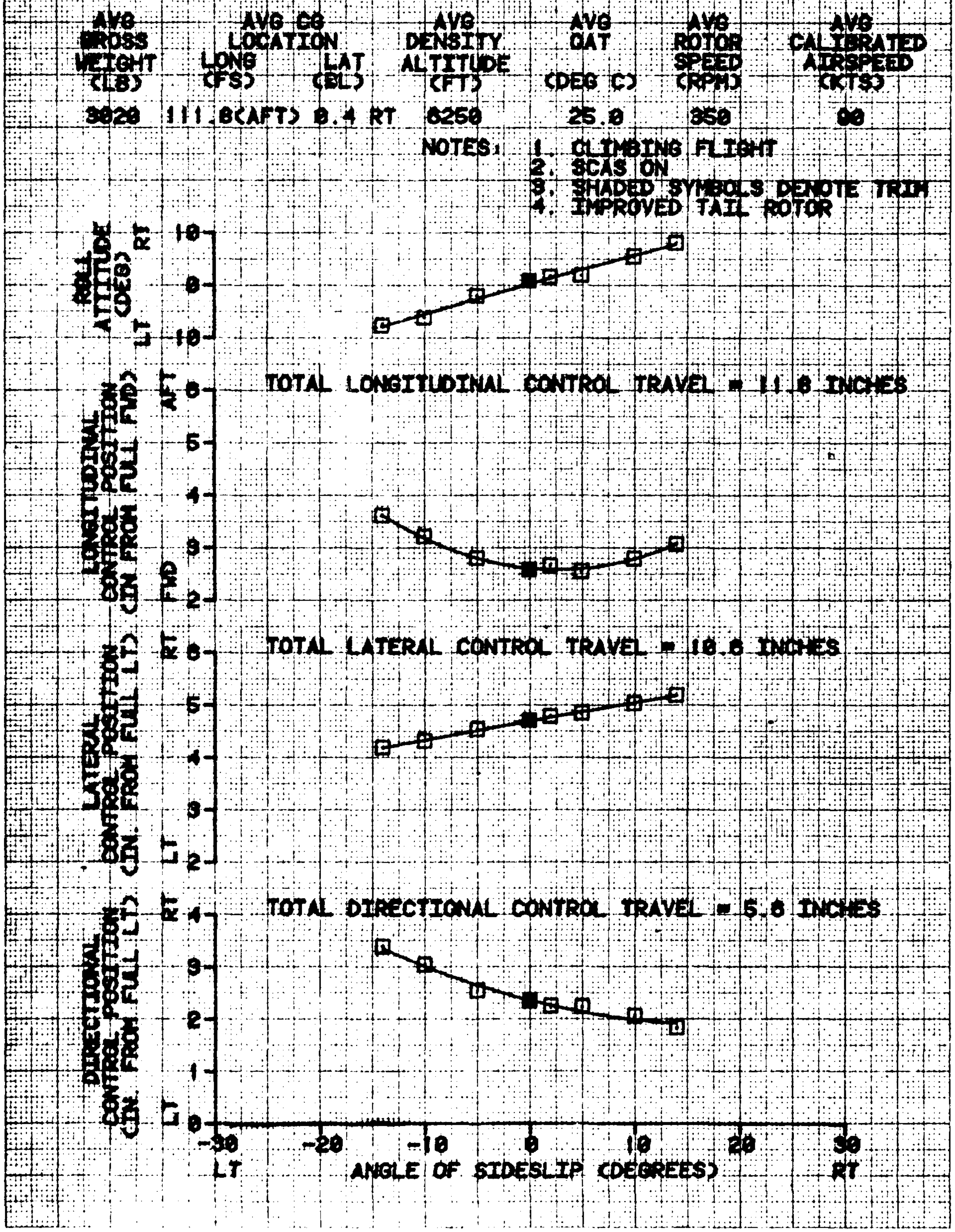


FIGURE 19
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16850



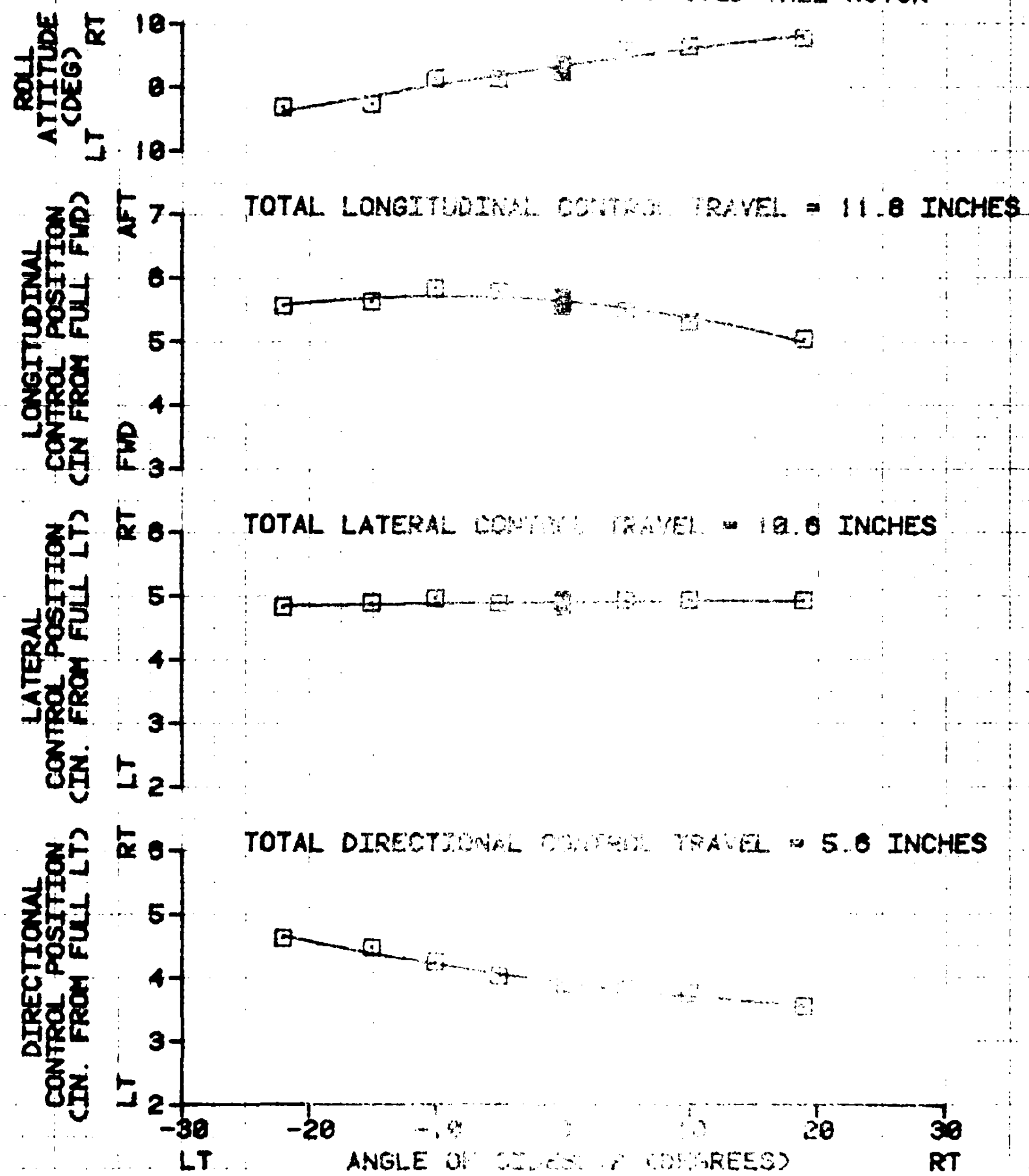
FIGURE

STATIC LATERAL-DIRECTIONAL STABILITY

OH-58C USA S/N 68-16052

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KTS)
2980	111.8(AFT)	0.4 RT	8000	22.5	353	60

NOTES: 1. AUTOROTATION
2. SCAS ON
3. SHADED SYMBOLS DENOTE TRIM
4. IMPROVED TAIL ROTOR



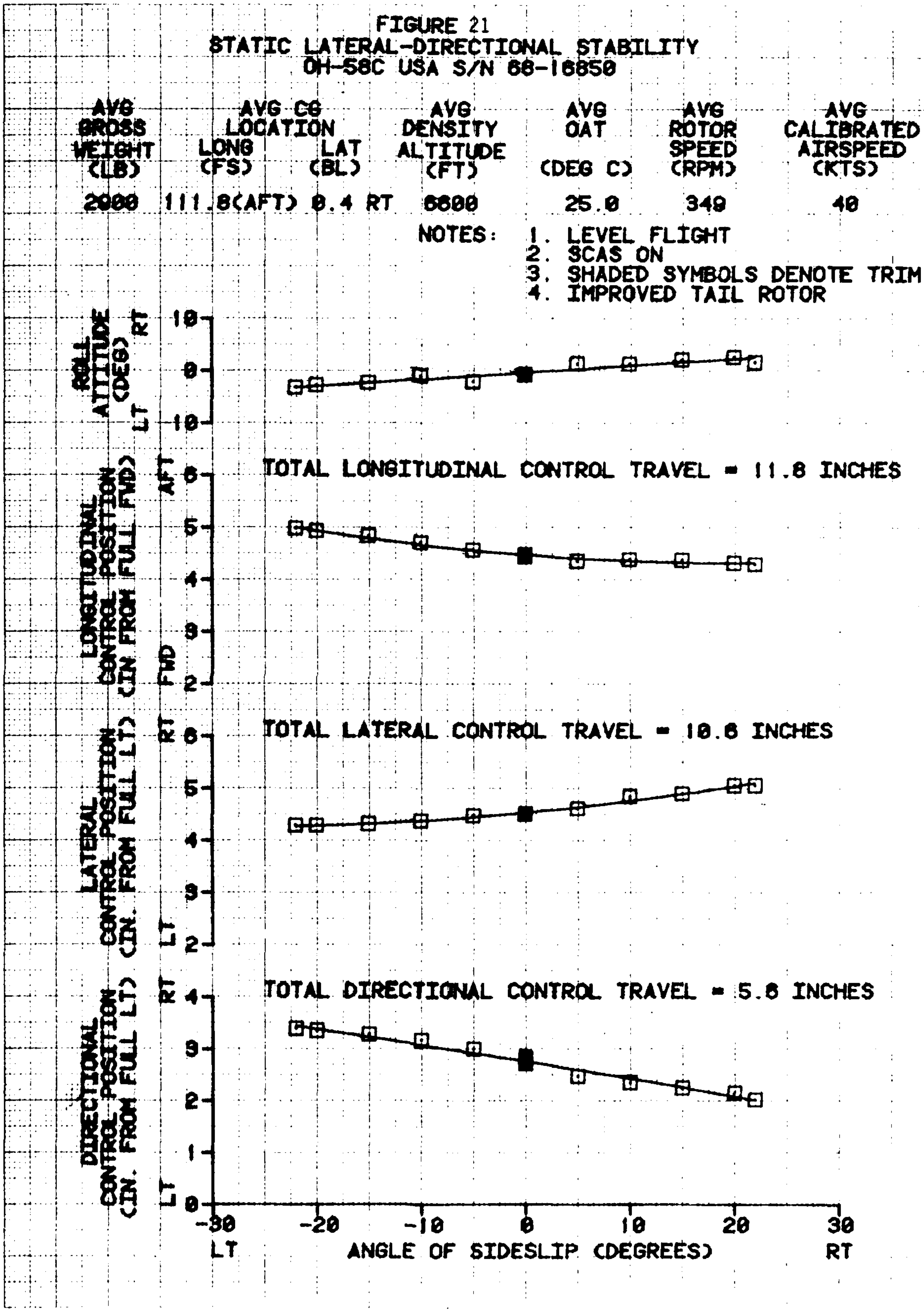
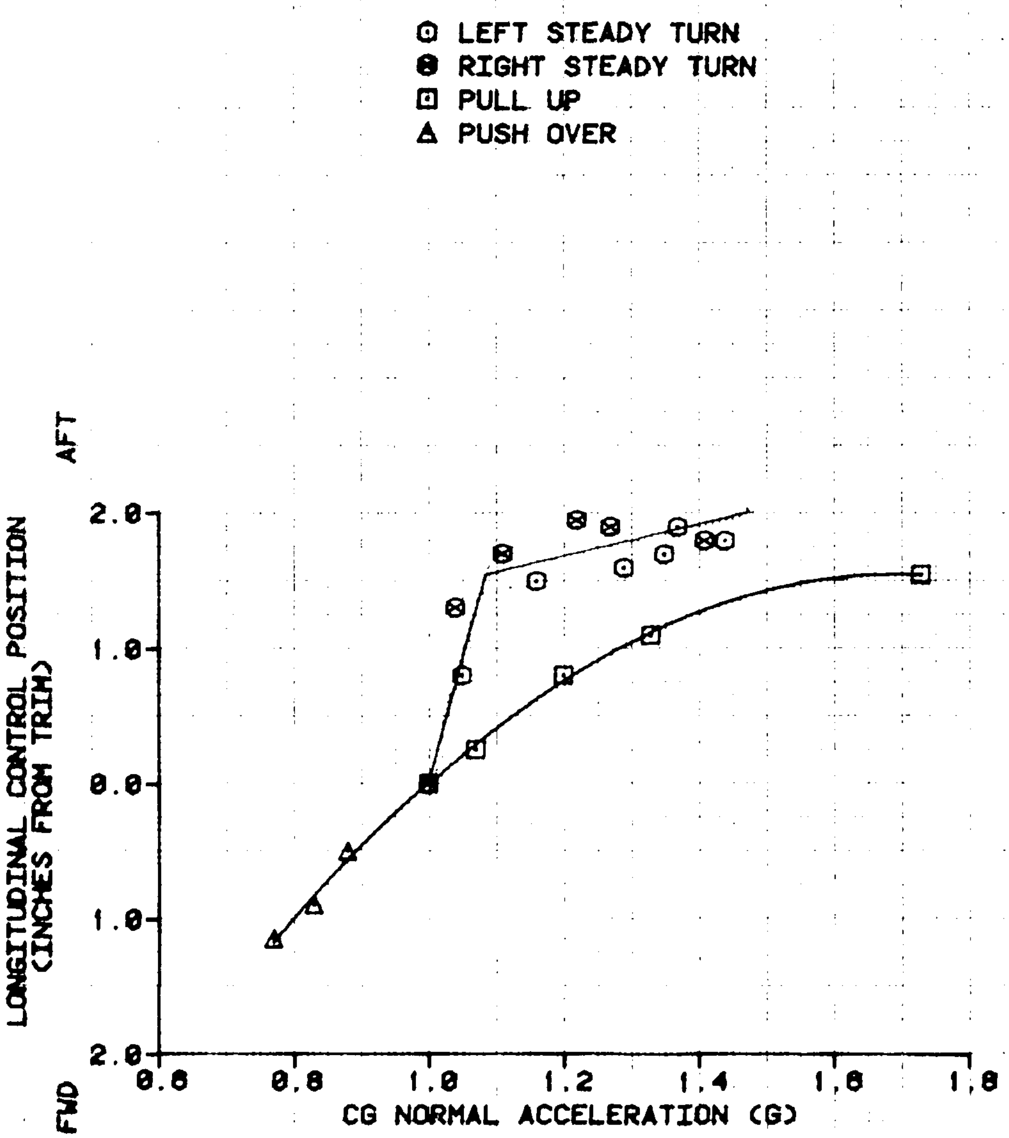


FIGURE 21
STATIC LATERAL-DIRECTIONAL STABILITY
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
AVG CALIBRATED AIRSPEED (KTS)
2900
111.8(AFT)
0.4 RT
6600
25.0
349
40
NOTES:
1. LEVEL FLIGHT
2. SCAS ON
3. SHADED SYMBOLS DENOTE TRIM
4. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
LT
RT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LT)
-30
-20
-10
0
10
20
30
LT
ANGLE OF SIDESLIP (DEGREES)
RT

FIGURE 22
MANEUVERING STABILITY
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KCAS)
2960	111.8(AFT)	0.4 LT	5000	27.0	354	90

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR



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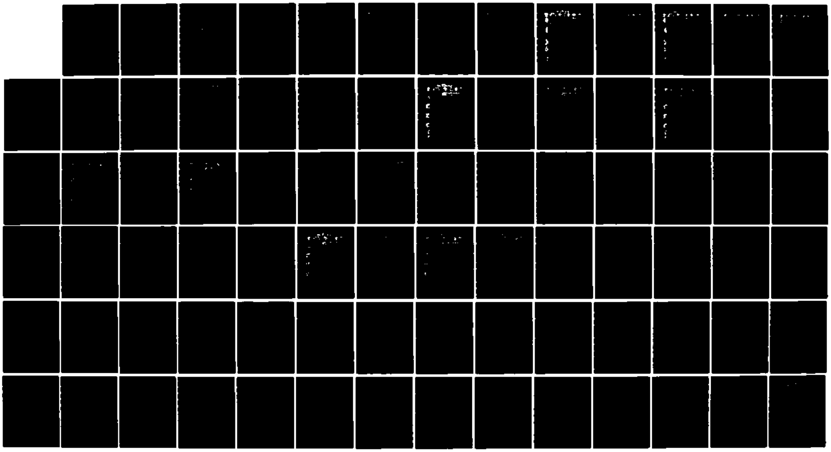

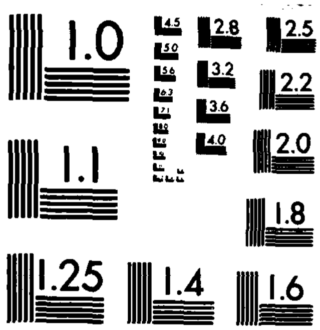

MICROCOPY RESOLUTION TEST CHART
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FIGURE 23
GUST RESPONSE IN LIGHT TURBULENCE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3050	111.8 (AFT)	0.3 RT	2600	23.0	353	90	LEVEL

NOTES: 1. SCAS OFF
2. IMPROVED TAIL ROTOR

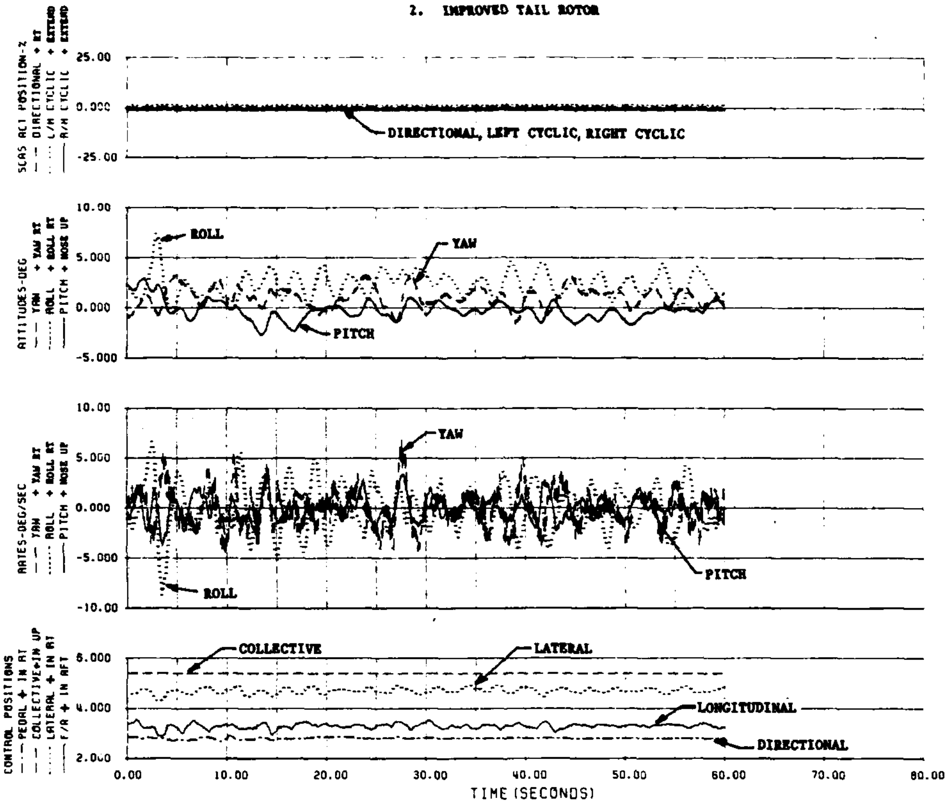


FIGURE 24
GUST RESPONSE IN LIGHT TURBULENCE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3040	111.8 (AFT)	0.3 RT	2600	23.0	353	90	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR

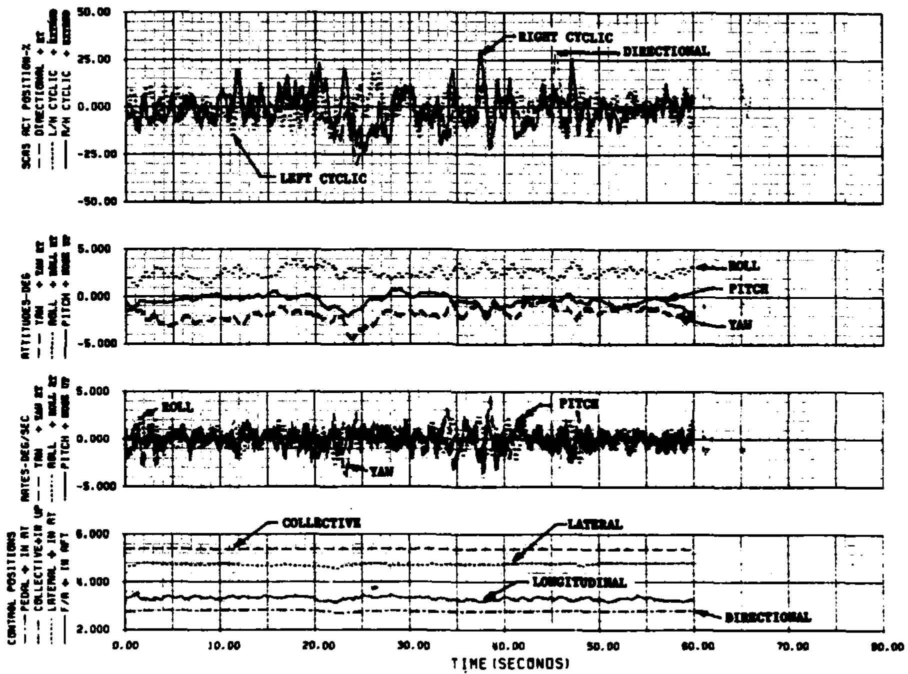


FIGURE 25
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2920	111.8 (AFT)	0.3 RT	6000	19.0	354	60	335 SHP CLIMB

NOTES: 1. SCAS OFF
2. IMPROVED TAIL ROTOR

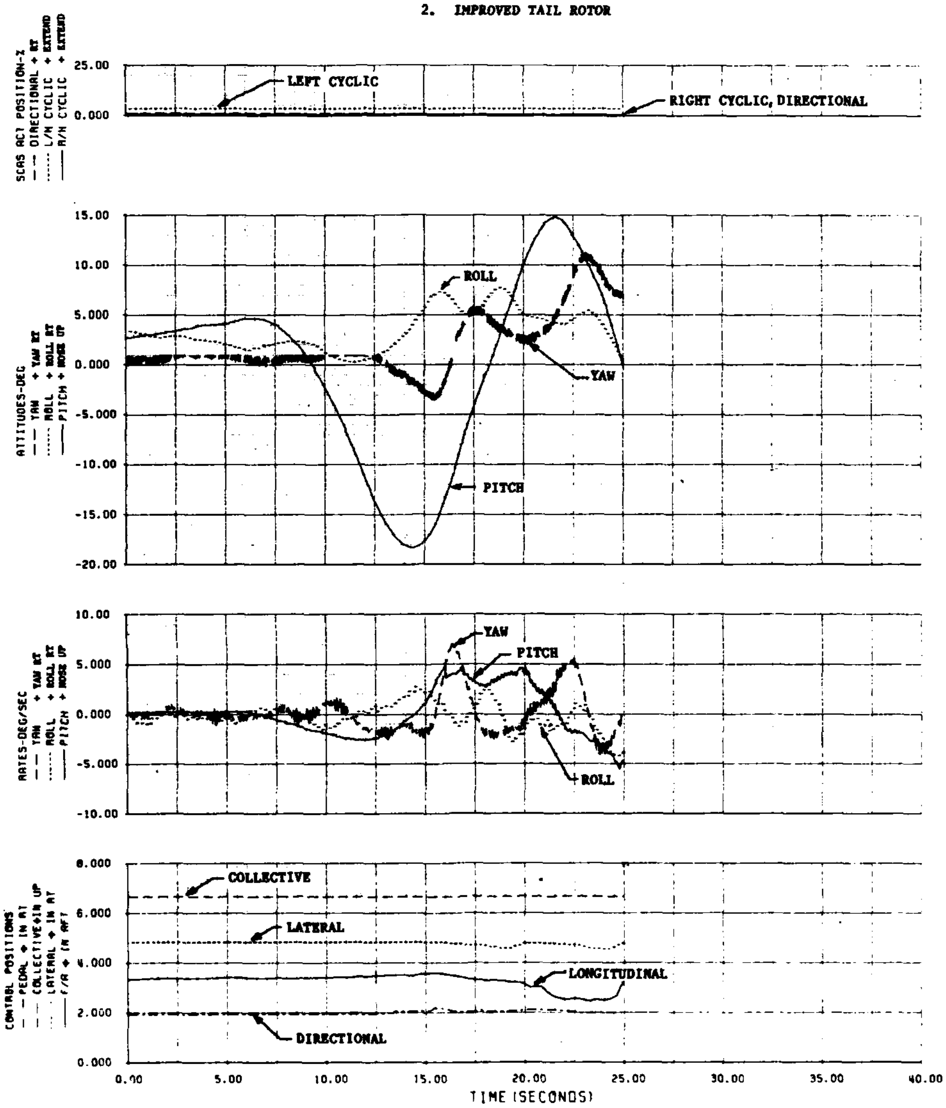
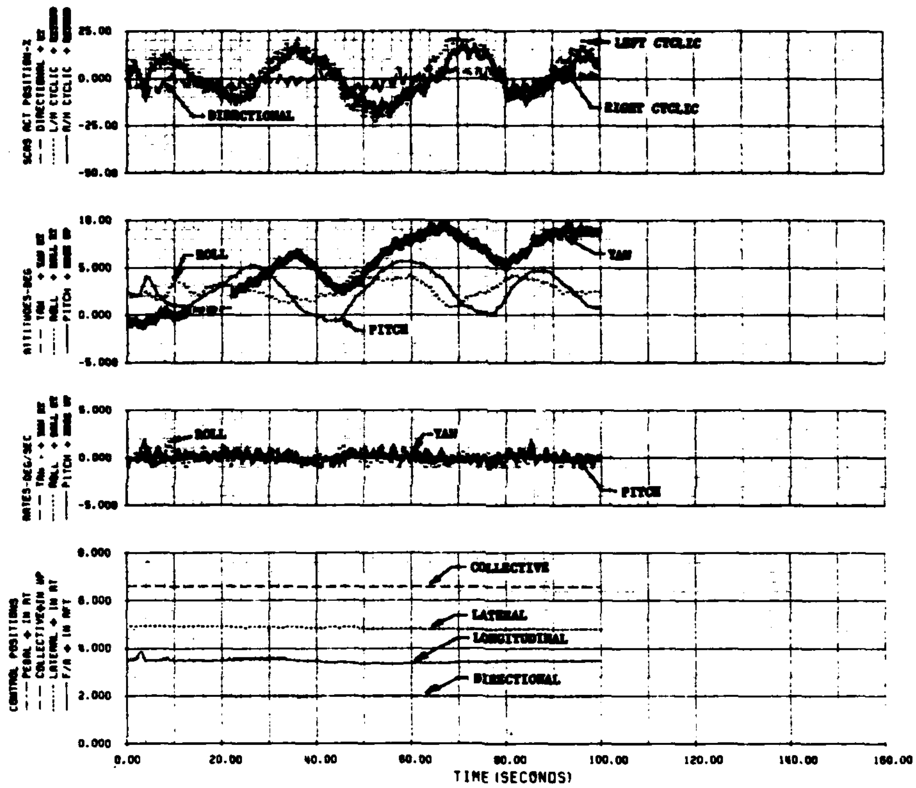


FIGURE 26
LONGITUDINAL LONG TERM RESPONSE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2920	111.8 (AFT)	0.3 RT	4500	20.5	[illegible]	60	335 SHP CLIMB

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR



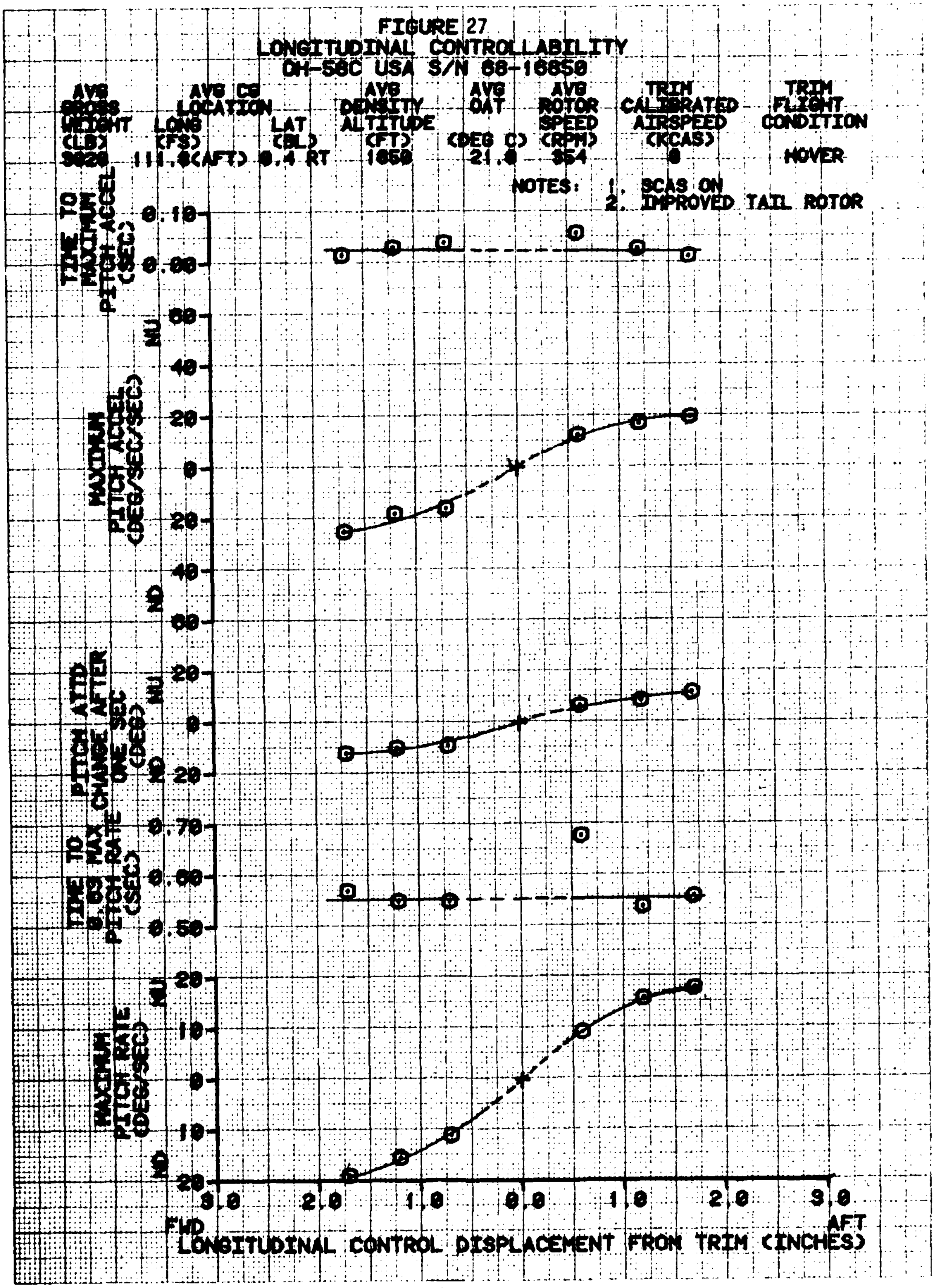
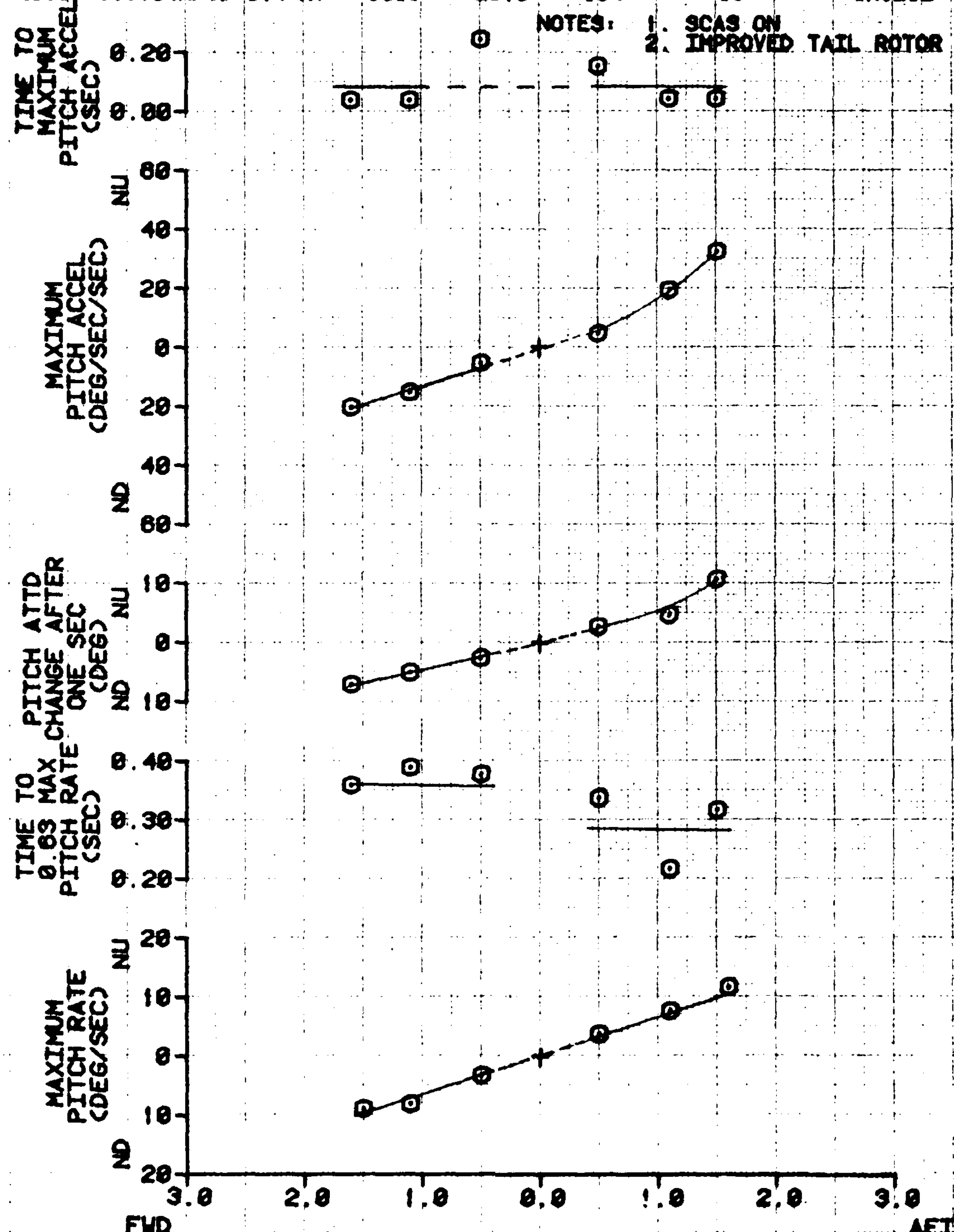


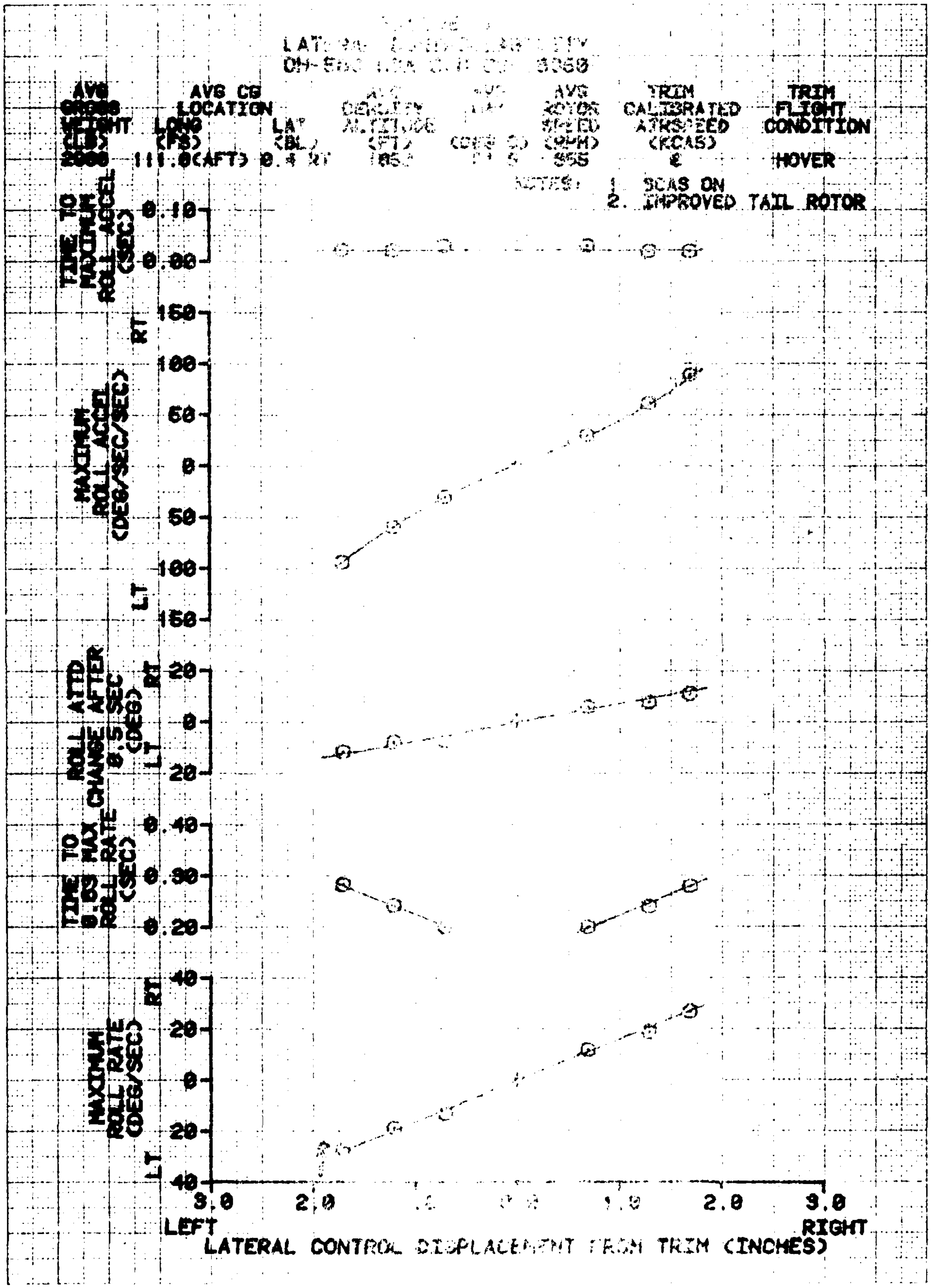
FIGURE 27
LONGITUDINAL CONTROLLABILITY
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3020
AVG CG LOCATION LONG (FS) 111.8(AFT) LAT (BL) 0.4 RT
AVG DENSITY ALTITUDE (FT) 1650
AVG OAT (DEG C) 21.0
AVG ROTOR SPEED (RPM) 354
TRIM CALIBRATED AIRSPEED (KCAS) 0
TRIM FLIGHT CONDITION HOVER
NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
TIME TO MAXIMUM PITCH ACCEL (SEC)
MAXIMUM PITCH ACCEL (DEG/SEC/SEC)
PITCH ATTD CHANGE AFTER ONE SEC (DEG)
TIME TO 0.63 MAX PITCH RATE (SEC)
MAXIMUM PITCH RATE (DEG/SEC)
NU
ND
FWD
AFT
LONGITUDINAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

FIGURE 28
LONGITUDINAL CONTROLLABILITY
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2900	111.8(AFT)	0.4 RT	5000	20.0	354	90	CRUISE

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR

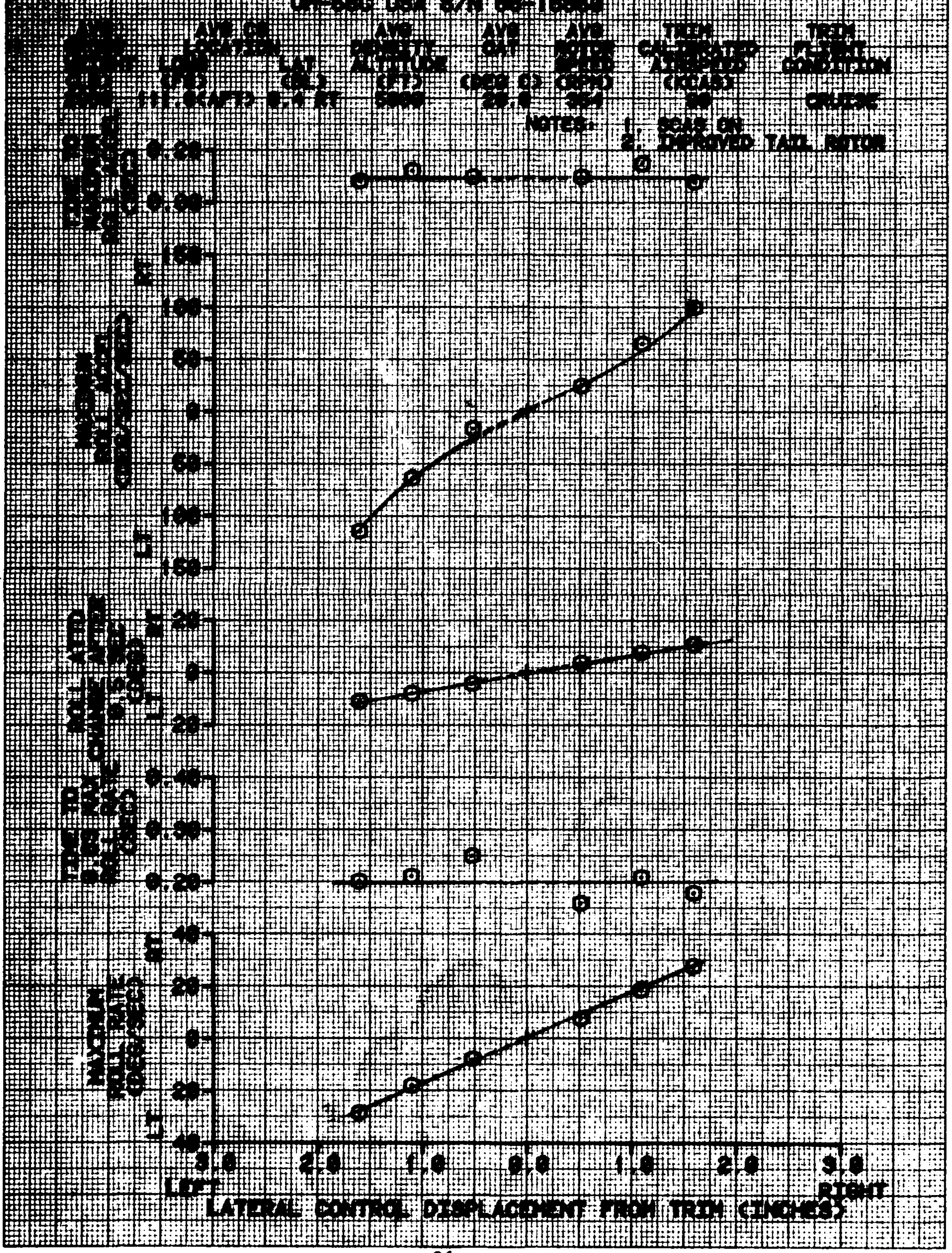




AVG GROSS WEIGHT (LB)
2990
AVG CG LOCATION
LONG (FS)
111.0(AFT)
LAT (BL)
0.4 RT
AVG ROTOR SPEED (RPM)
355
TRIM CALIBRATED AIRSPEED (KCAS)
TRIM FLIGHT CONDITION
HOVER
1. SCAS ON
2. IMPROVED TAIL ROTOR
TIME TO MAXIMUM ROLL ACCEL (SEC)
MAXIMUM ROLL ACCEL (DEG/SEC/SEC)
ROLL ATTD CHANGE AFTER 0.5 SEC (DEG)
TIME TO 0.63 MAX ROLL RATE (SEC)
MAXIMUM ROLL RATE (DEG/SEC)
RT
LT
LEFT
RIGHT
LATERAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

FIGURE 30

LATERAL CONTROLLABILITY



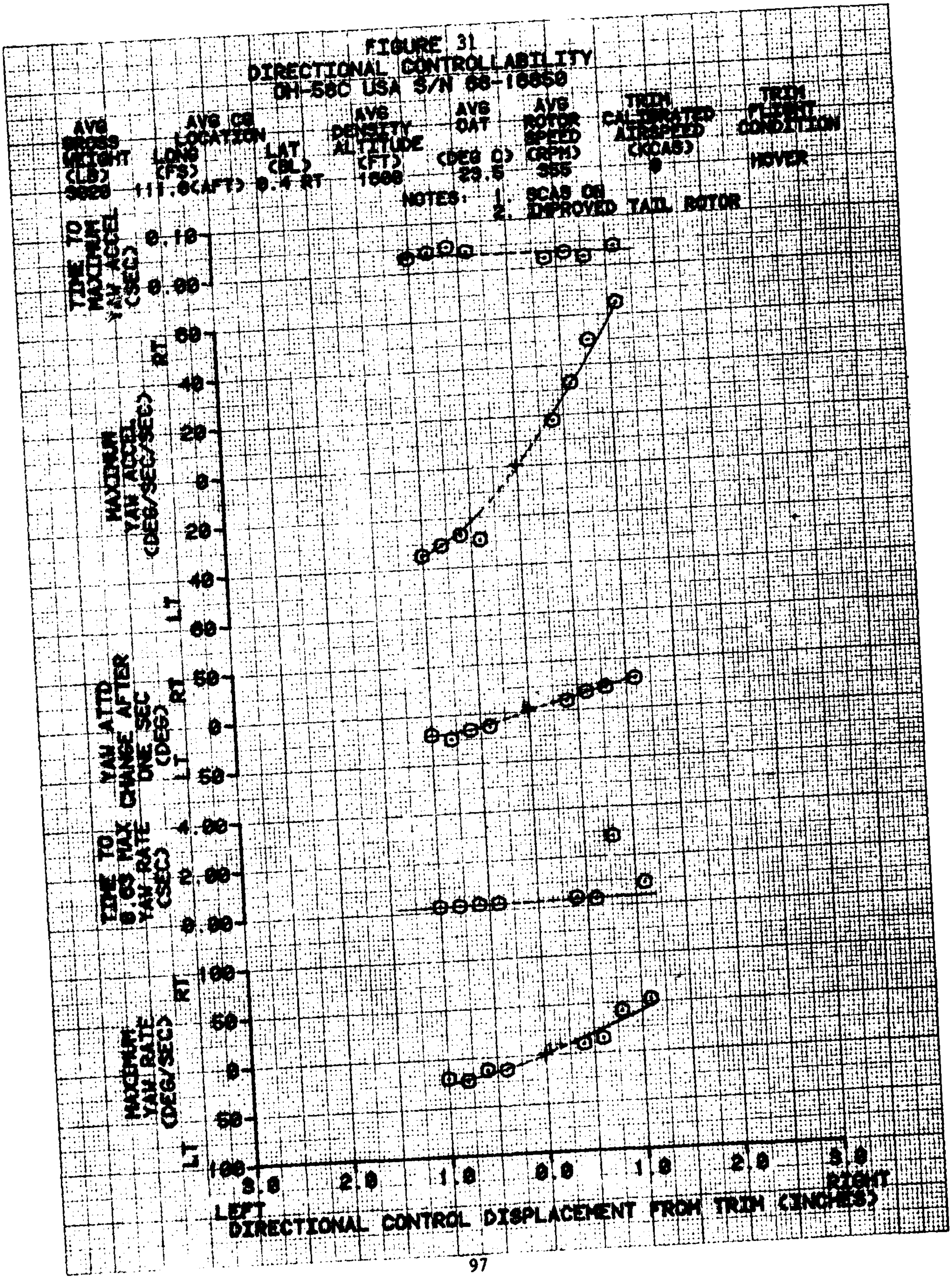


FIGURE 31
DIRECTIONAL CONTROLLABILITY
OH-58C USA S/N 68-16850

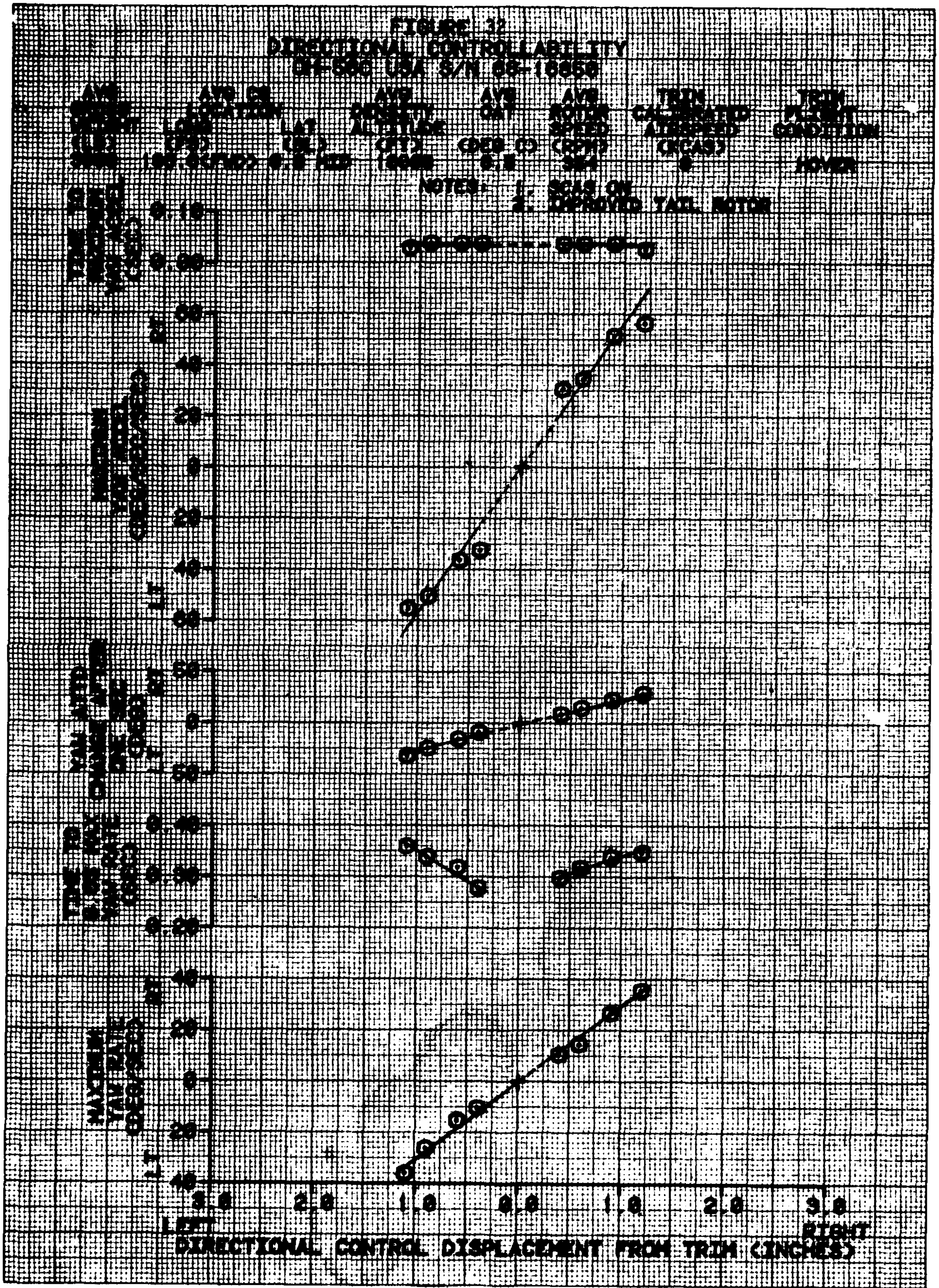


FIGURE 32
DIRECTIONAL CONTROLLABILITY
HOVER
NOTES:
2. IMPROVED TAIL ROTOR
3.0
2.0
1.0
0.0
1.0
2.0
3.0
LEFT
RIGHT
DIRECTIONAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

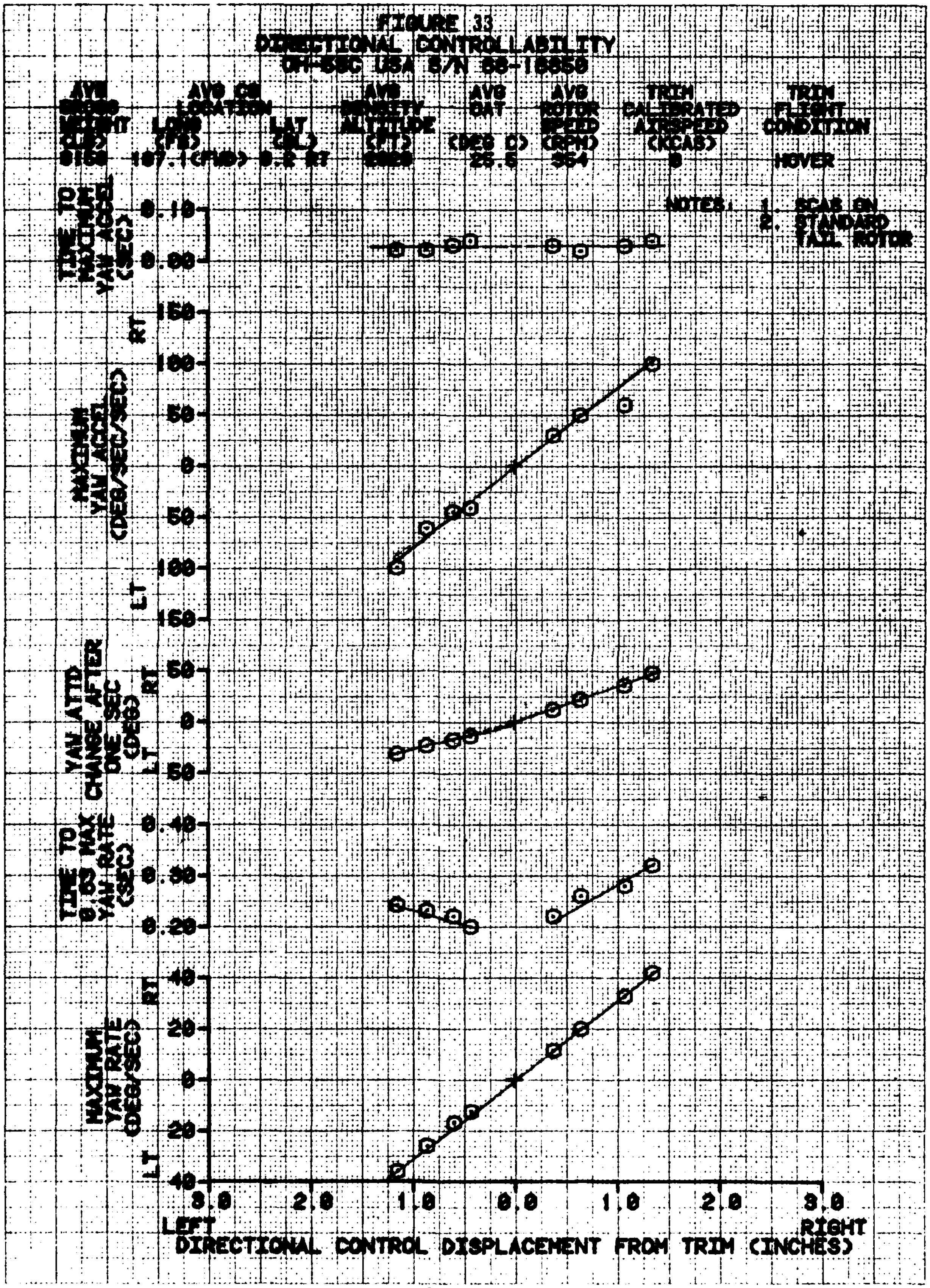


FIGURE 33
DIRECTIONAL CONTROLLABILITY
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KCAS)
TRIM FLIGHT CONDITION
25.5
354
0
HOVER
NOTES: 1. SCAS ON
2. STANDARD TAIL ROTOR
TIME TO MAXIMUM YAW ACCEL (SEC)
0.10
0.00
MAXIMUM YAW ACCEL (DEG/SEC/SEC)
RT
LT
150
100
50
0
50
100
150
YAW ATTD CHANGE AFTER ONE SEC (DEG)
RT
LT
50
0
50
TIME TO 0.63 MAX YAW RATE (SEC)
0.40
0.30
0.20
MAXIMUM YAW RATE (DEG/SEC)
RT
LT
40
20
0
20
40
3.0
2.0
1.0
0.0
1.0
2.0
3.0
LEFT
RIGHT
DIRECTIONAL CONTROL DISPLACEMENT FROM TRIM (INCHES)

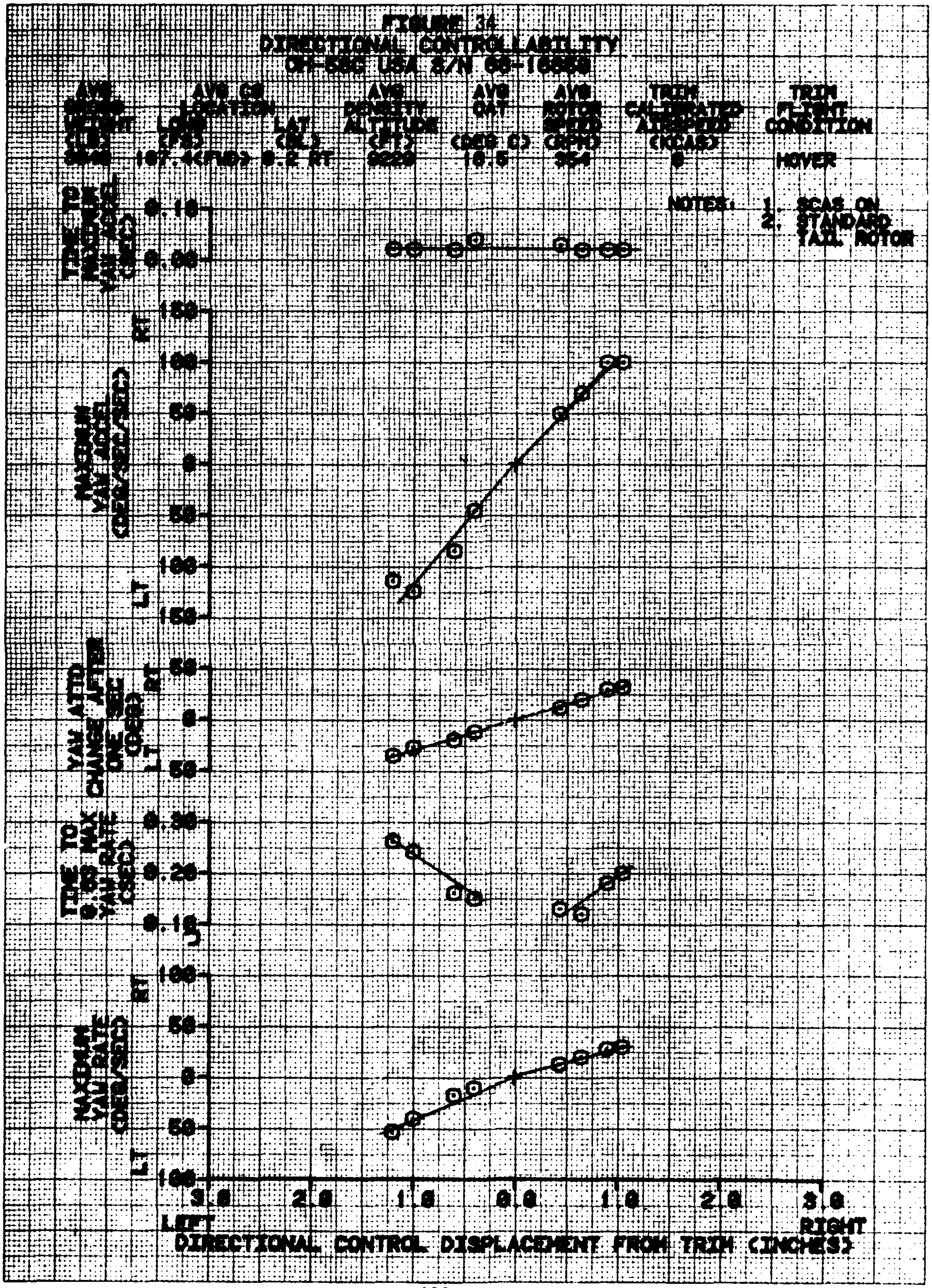
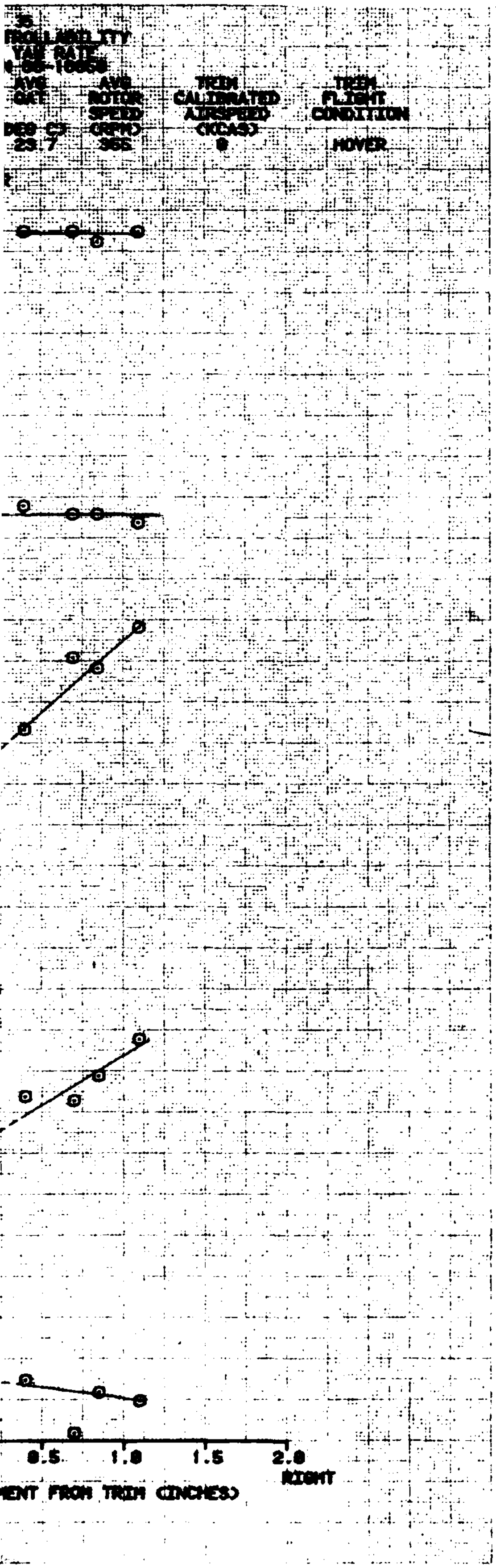


FIGURE 34
DIRECTIONAL CONTROLLABILITY
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KCAS)
TRIM FLIGHT CONDITION
HOVER
NOTES: 1. SCAS ON
2. STANDARD TAIL ROTOR
TIME TO MAXIMUM YAW ACCEL (SEC)
MAXIMUM YAW ACCEL (DEG/SEC/SEC)
YAW ATTITUDE CHANGE AFTER ONE SEC (DEG)
TIME TO 63% MAX YAW RATE (SEC)
MAXIMUM YAW RATE (DEG/SEC)
RT
LT
LEFT
RIGHT
DIRECTIONAL CONTROL DISPLACEMENT FROM TRIM (INCHES)


AVG ROTOR SPEED (RPM)
TRIM CALIBRATED AIRSPEED (KCAS)
TRIM FLIGHT CONDITION
23.7
355
0
HOVER
0.5
1.0
1.5
2.0
RIGHT
FROM TRIM (INCHES)

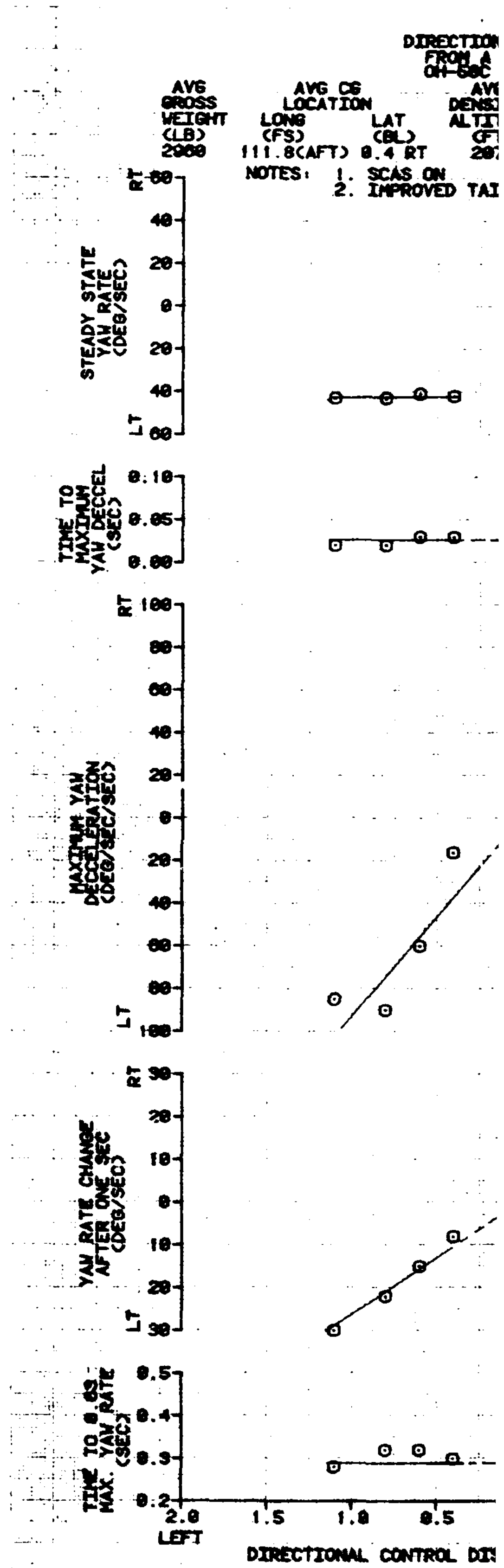
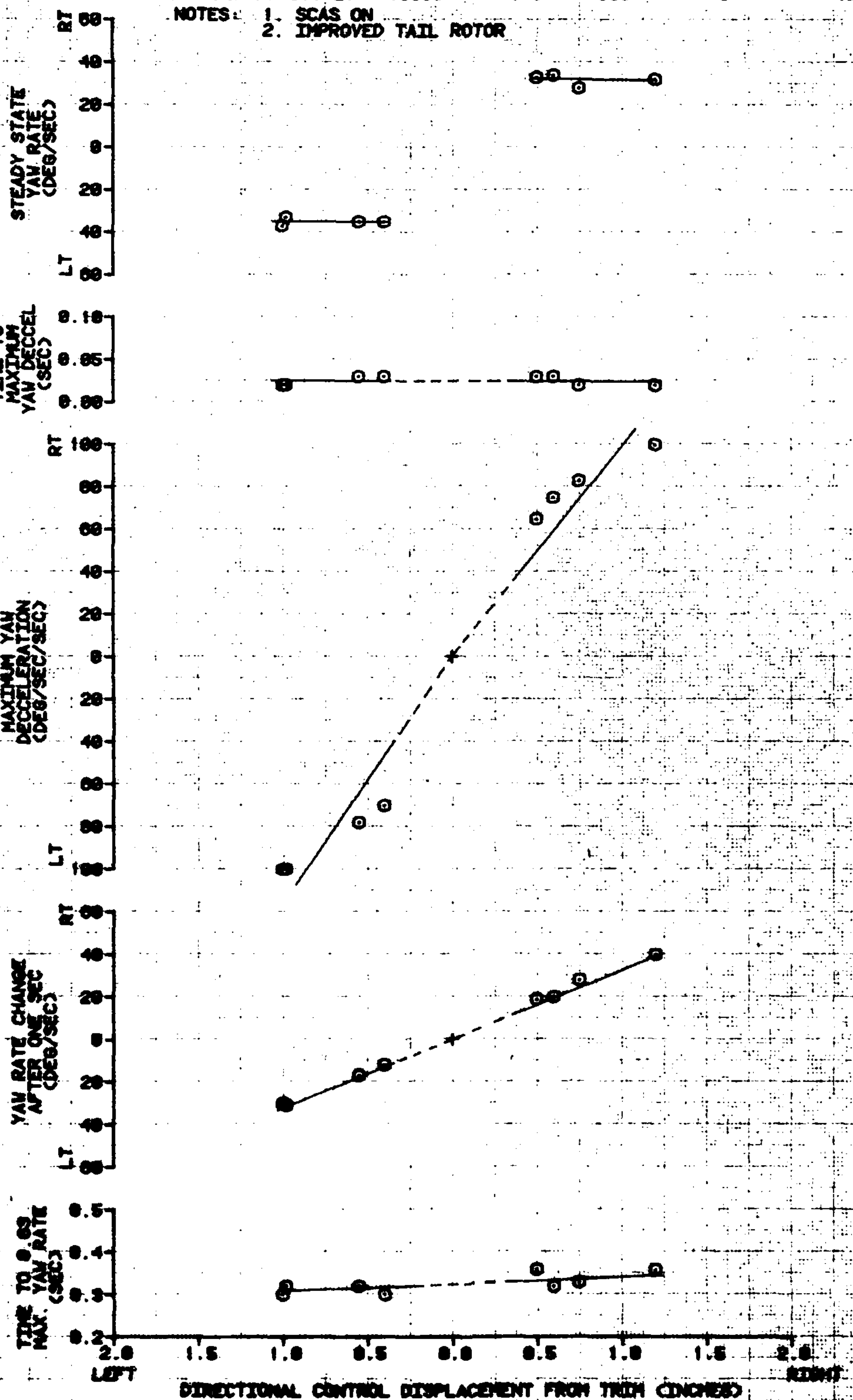

AVG GROSS WEIGHT (LB)
2960
AVG CG LOCATION
LONG (FS)
111.8(AFT)
LAT (BL)
0.4 RT
NOTES: 1. SCAS ON
STEADY STATE YAW RATE (DEG/SEC)
TIME TO MAXIMUM YAW DECCEL (SEC)
MAXIMUM YAW DECCELERATION (DEG/SEC/SEC)
YAW RATE CHANGE AFTER ONE SEC (DEG/SEC)
TIME TO 0.63 MAX. YAW RATE (SEC)
RT
LT
LEFT
2.0
1.5
1.0
0.5

FIGURE 37
DIRECTIONAL CONTROLLABILITY
FROM A STEADY YAW RATE
OH-58C USA S/N 68-16060

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2960	107.7(FWD)	0.1 LT	10360	6.0	355	0	HOVER

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR



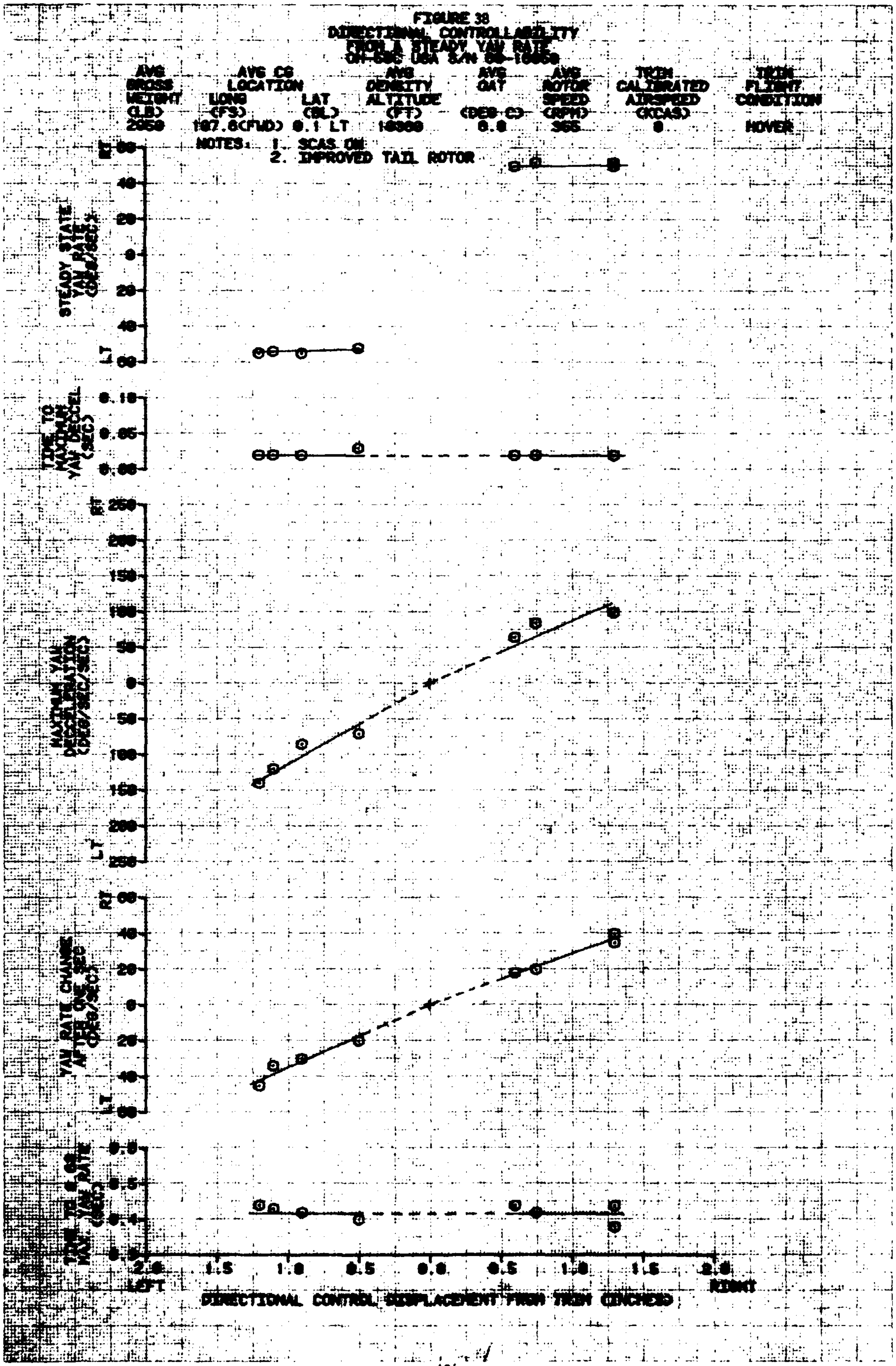


FIGURE 38
DIRECTIONAL CONTROLLABILITY
FROM A STEADY YAW RATE
OH-58C USA S/N 68-16850

FIGURE 39
LOW SPEED FLIGHT 90 DEGREE AZIMUTH
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRUE AIRSPEED (KTAS)
3020	106.1 (FWD)	0.4 RT	11,200	3.0	356	24.2

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. 10 FOOT SKID HEIGHT

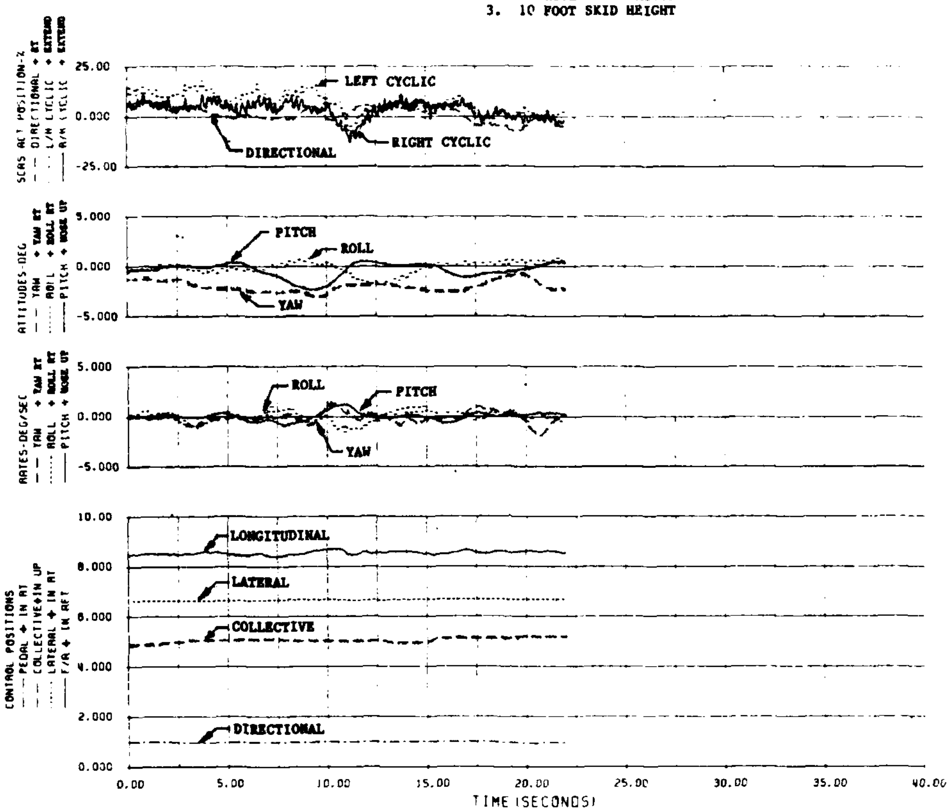


FIGURE 40
LOW SPEED FLIGHT 180 DEGREE AZIMUTH
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRUE AIRSPEED (KTAS)
3010	106.1 (FWD)	0.4 RT	11,150	11.0	357	25.0

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. 10 FOOT SKID HEIGHT

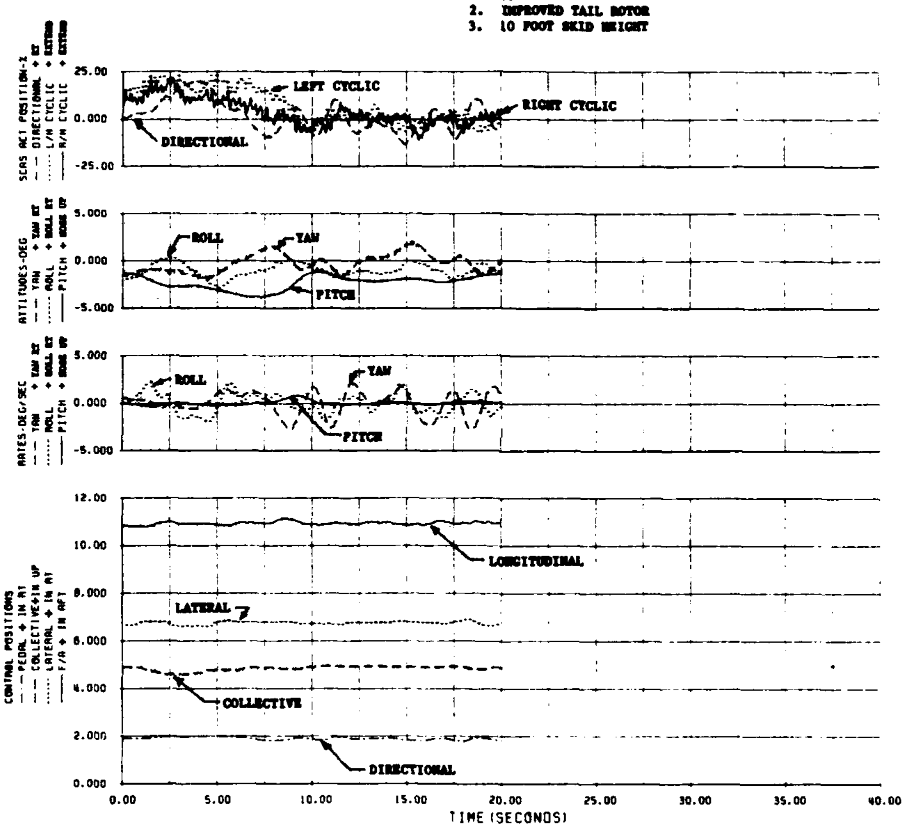
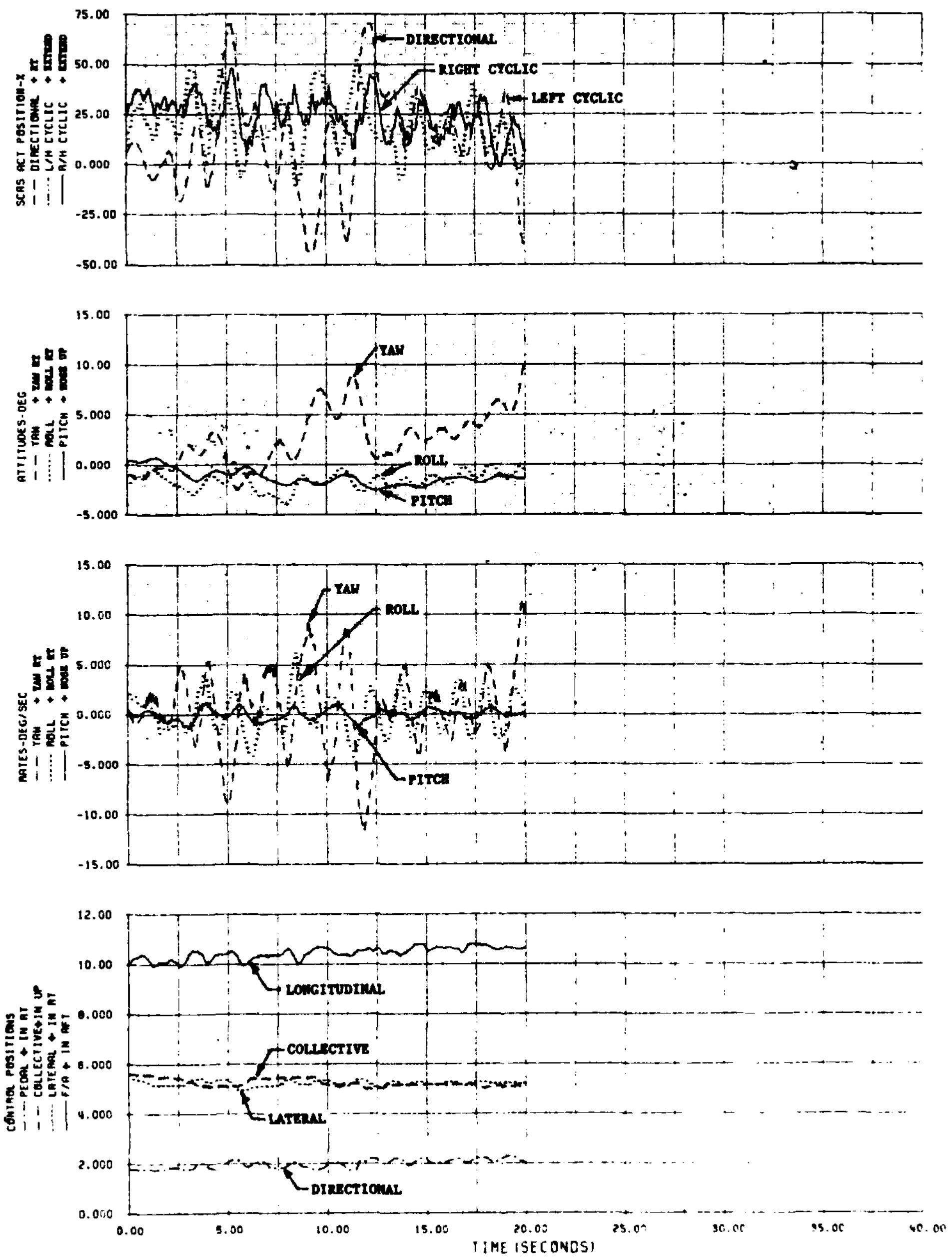


FIGURE 41
LOW SPEED FLIGHT 225 DEGREE AZIMUTH
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRUE AIRSPEED (KTAS)
3010	106.1 (FWD)	0.4 RT	11,300	14.5	356	25.0

NOTES:
1. SCAS ON
2. IMPROVED TAIL ROTOR
3. 10 FOOT SKID HEIGHT



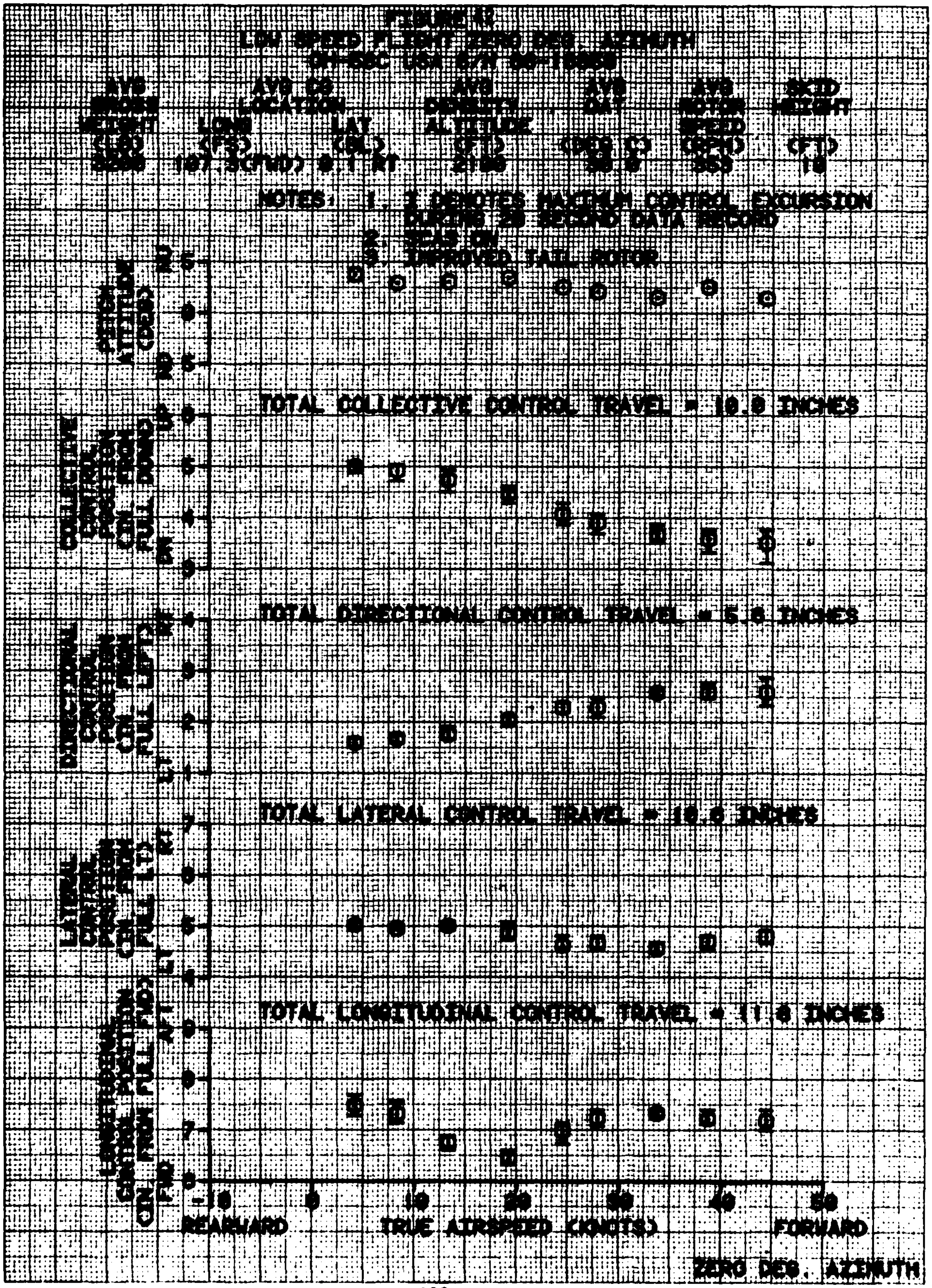
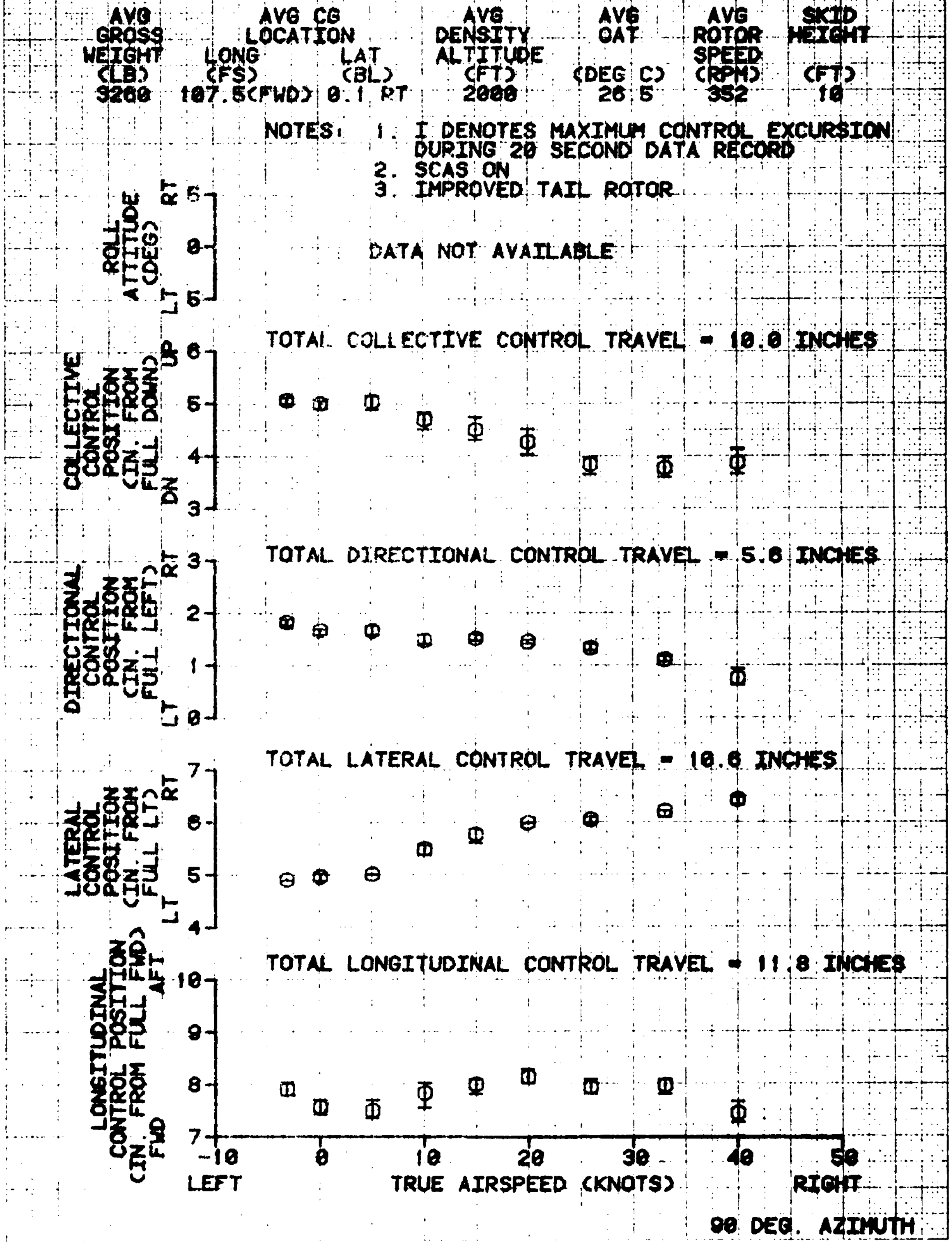

LOW SPEED FLIGHT ZERO DEG. AZIMUTH
NOTES:
IMPROVED TAIL ROTOR
TOTAL COLLECTIVE CONTROL TRAVEL = 10.8 INCHES
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.4 INCHES
-10
0
10
20
30
40
50
REARWARD
TRUE AIRSPEED (KNOTS)
FORWARD
ZERO DEG. AZIMUTH

FIGURE 43
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850



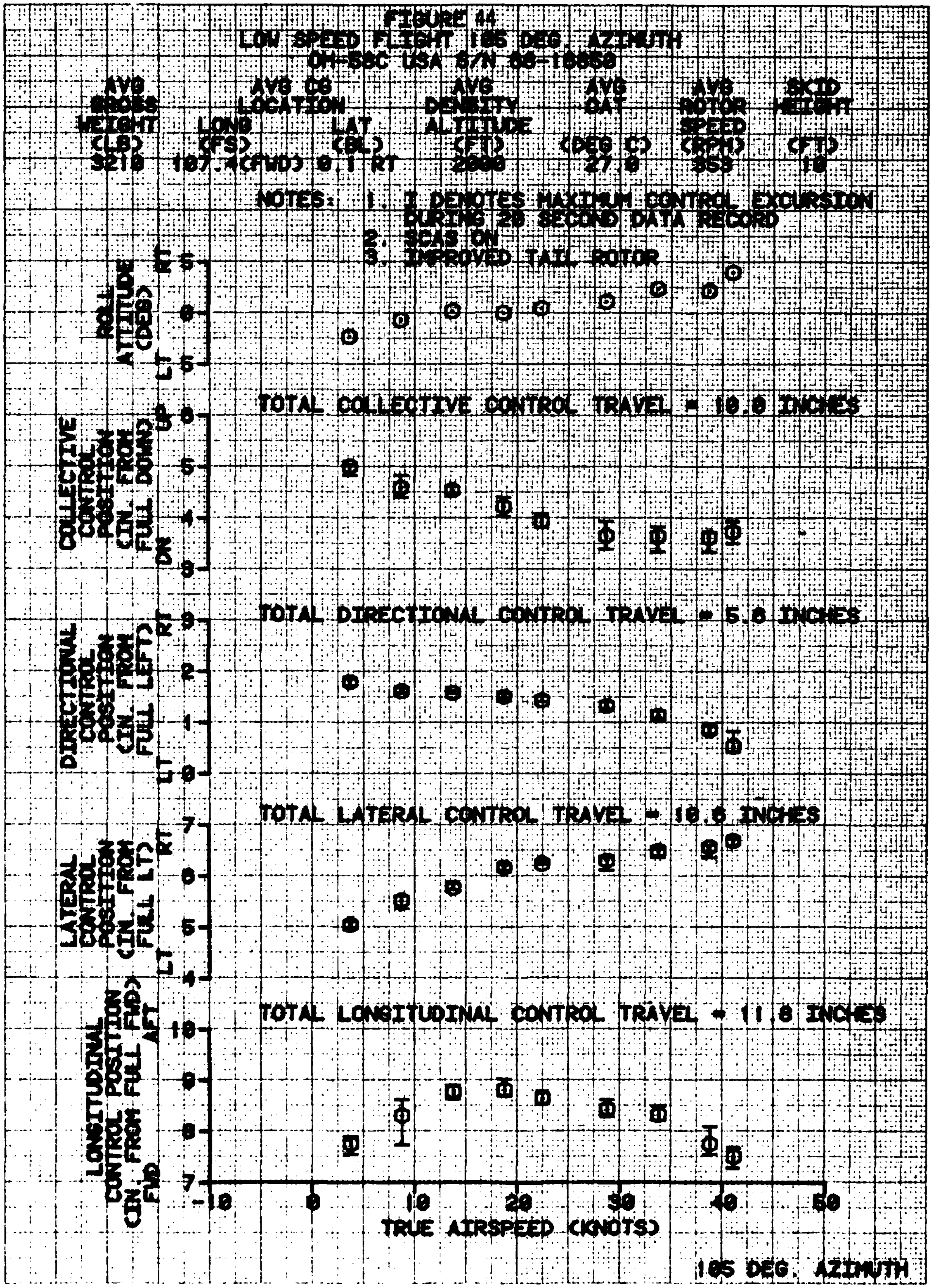


FIGURE 44
LOW SPEED FLIGHT 105 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3210
AVG CG LOCATION LONG (FS) 107.4(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2000
AVG OAT (DEG C) 27.0
AVG ROTOR SPEED (RPM) 353
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
TRUE AIRSPEED (KNOTS)
105 DEG. AZIMUTH

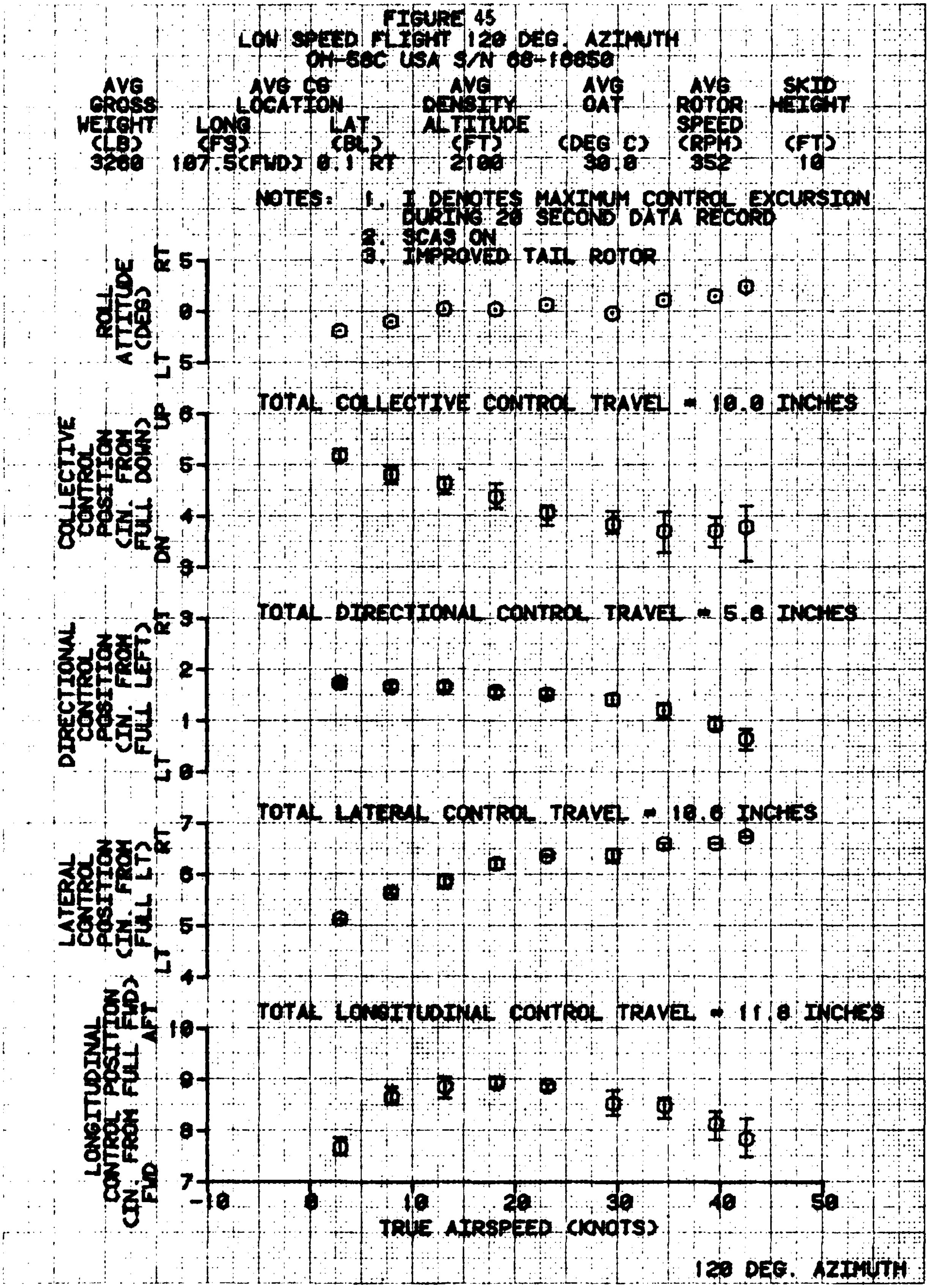


FIGURE 45
LOW SPEED FLIGHT 120 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3260
AVG CG LOCATION LONG (FS) 107.5(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2100
AVG OAT (DEG C) 30.0
AVG ROTOR SPEED (RPM) 352
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
TRUE AIRSPEED (KNOTS)
120 DEG. AZIMUTH

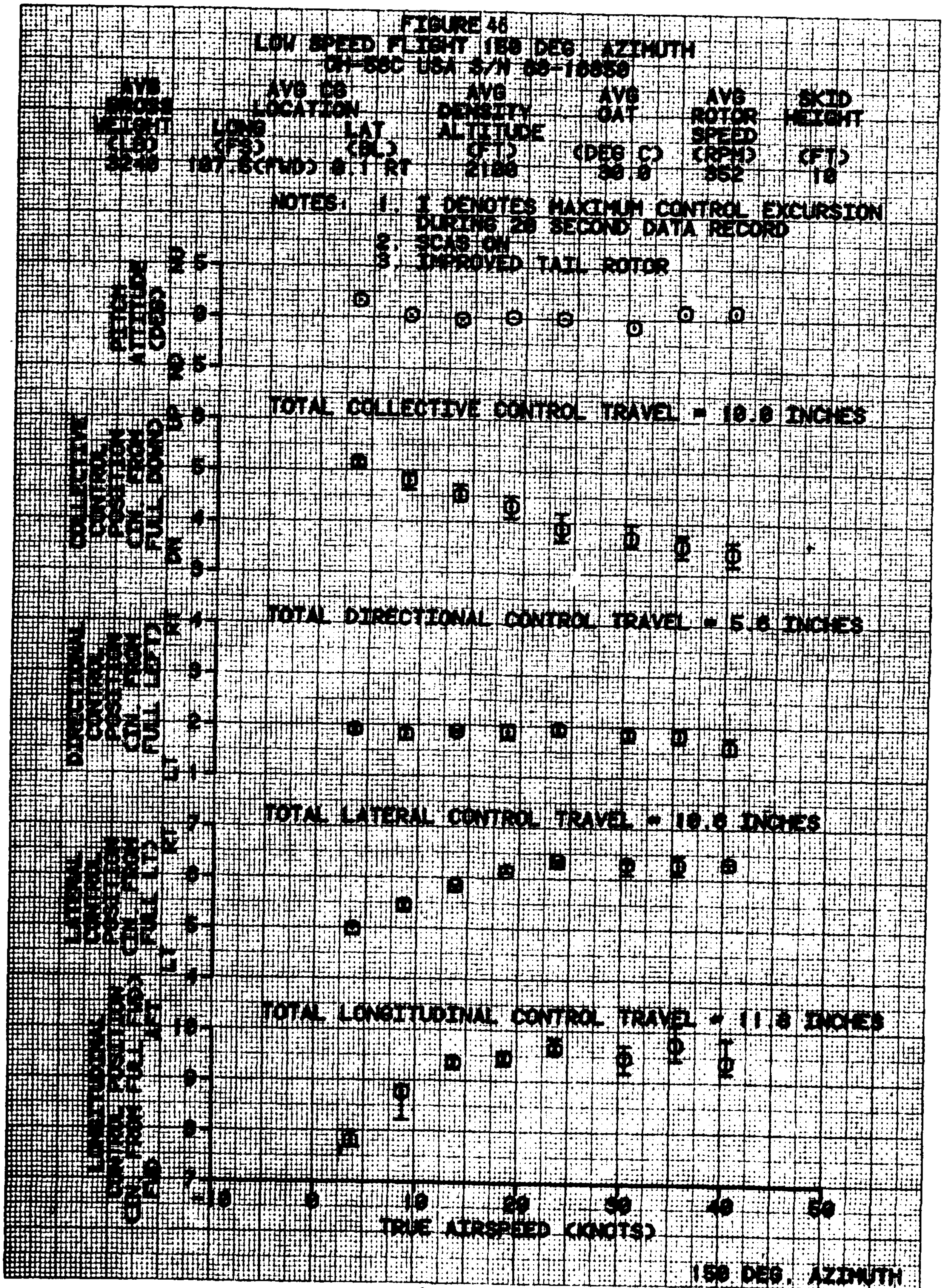


FIGURE 46
LOW SPEED FLIGHT 150 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3240
AVG CG LOCATION LONG (FS) 107.5(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2180
AVG OAT (DEG C) 20.0
AVG ROTOR SPEED (RPM) 352
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG)
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL AFT)
TRUE AIRSPEED (KNOTS)
150 DEG. AZIMUTH

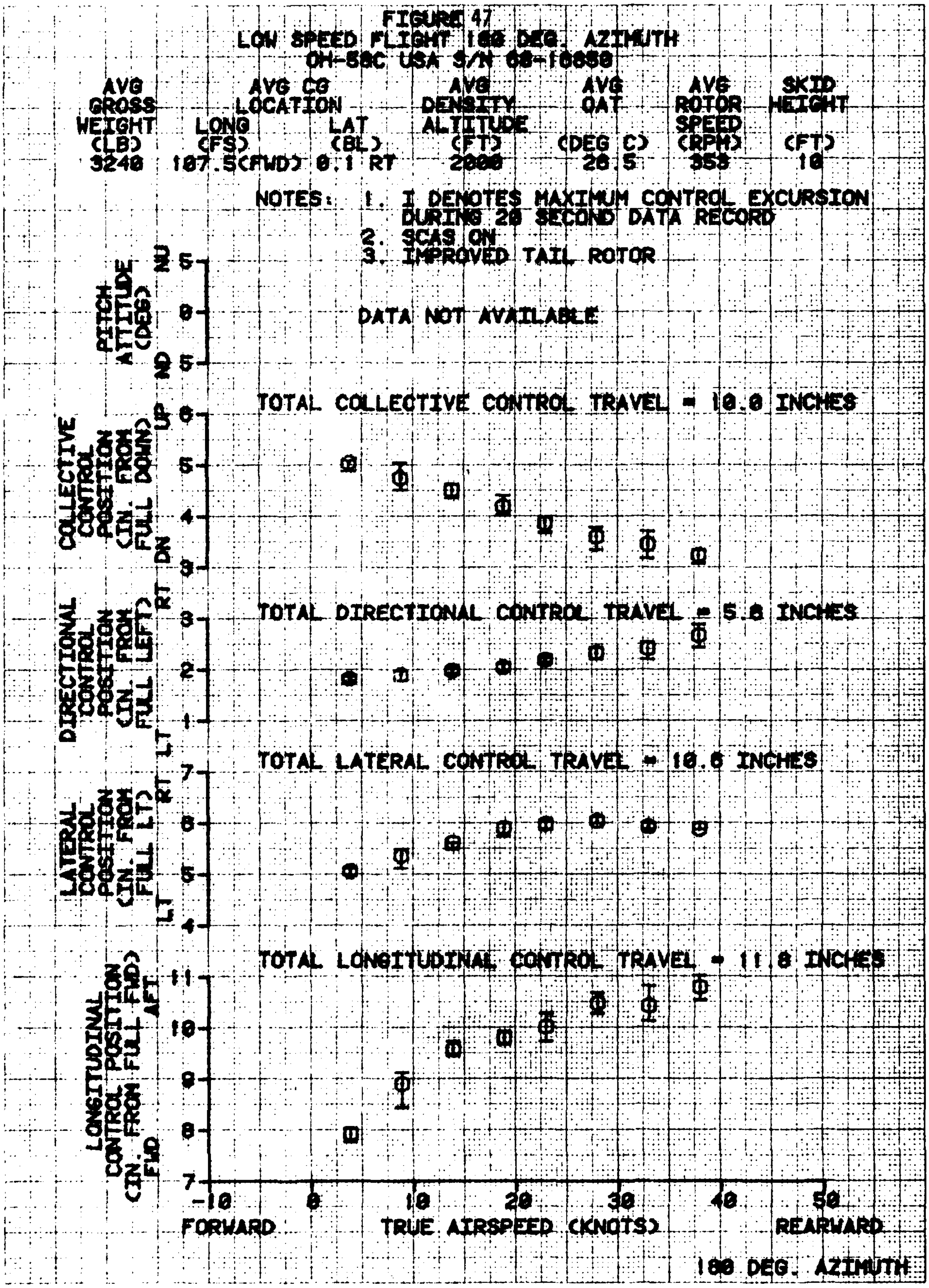


FIGURE 47
LOW SPEED FLIGHT 180 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3240
AVG CG LOCATION LONG (FS) 107.5(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2000
AVG OAT (DEG C) 26.5
AVG ROTOR SPEED (RPM) 353
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG)
NU
ND
DATA NOT AVAILABLE
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
-10
0
10
20
30
40
50
FORWARD
TRUE AIRSPEED (KNOTS)
REARWARD
180 DEG. AZIMUTH

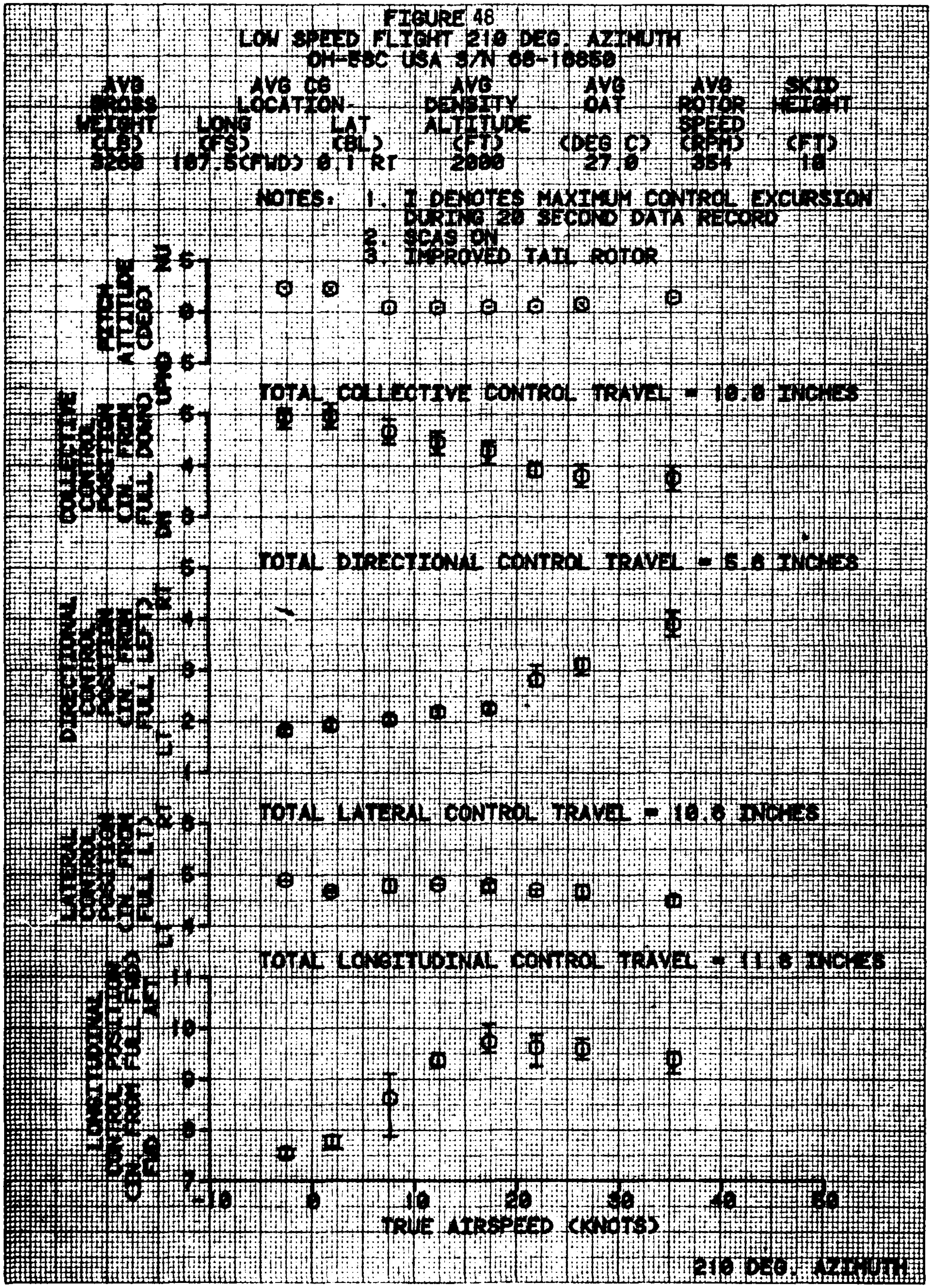
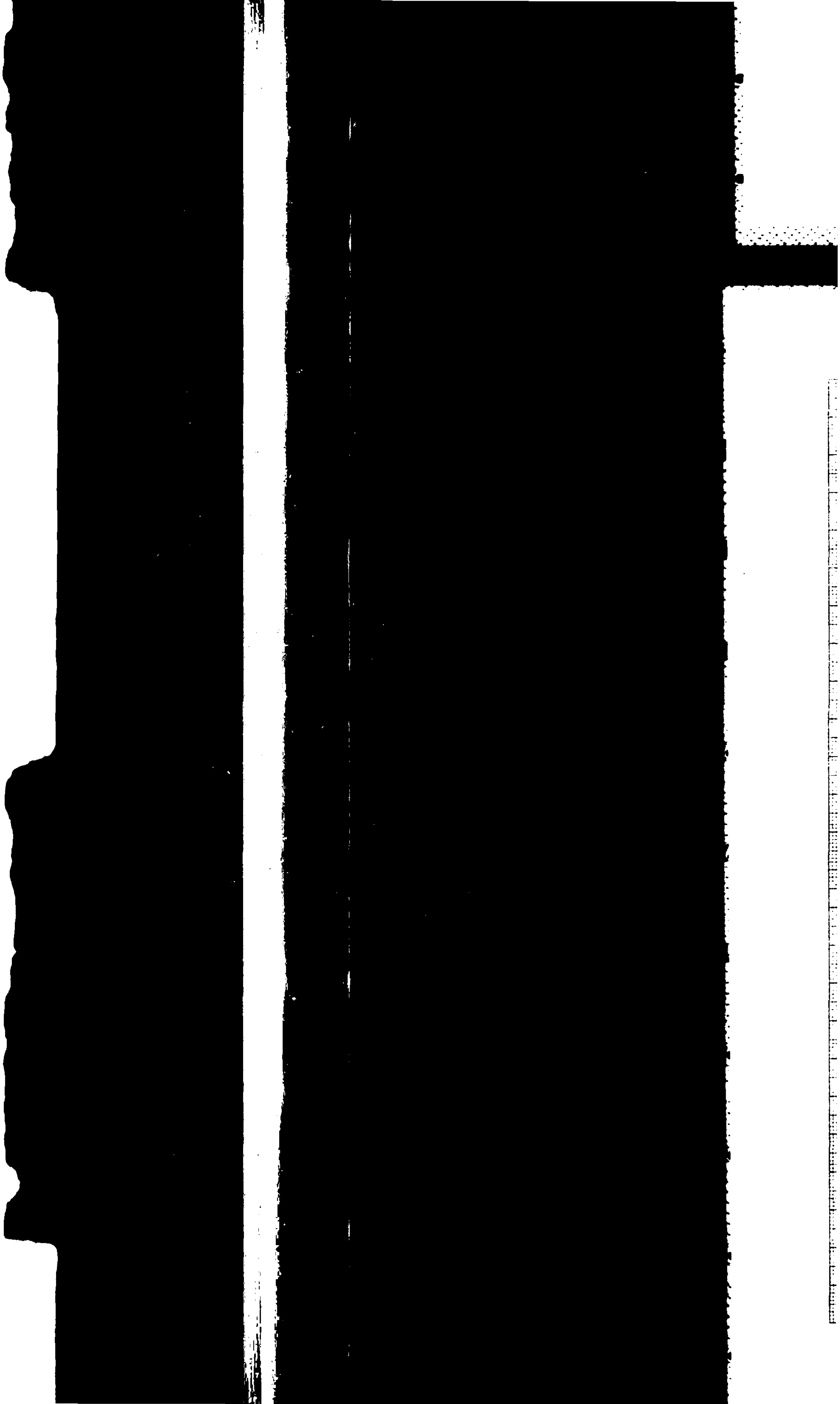
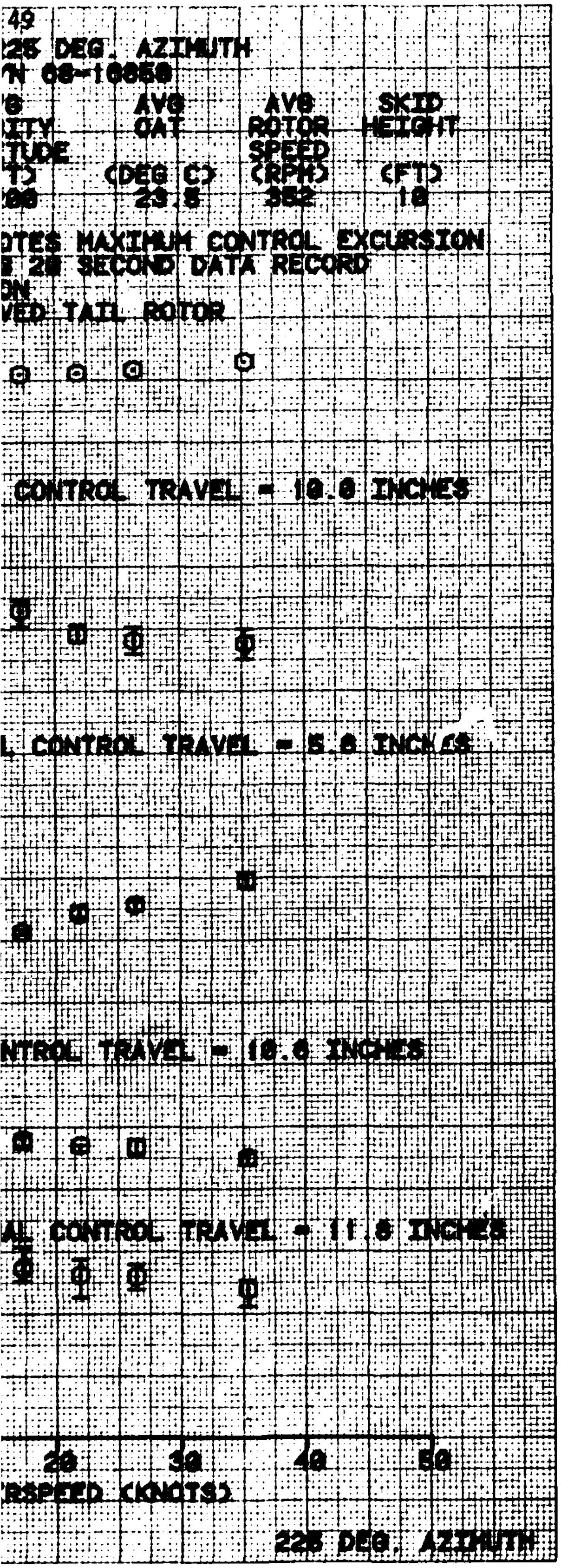
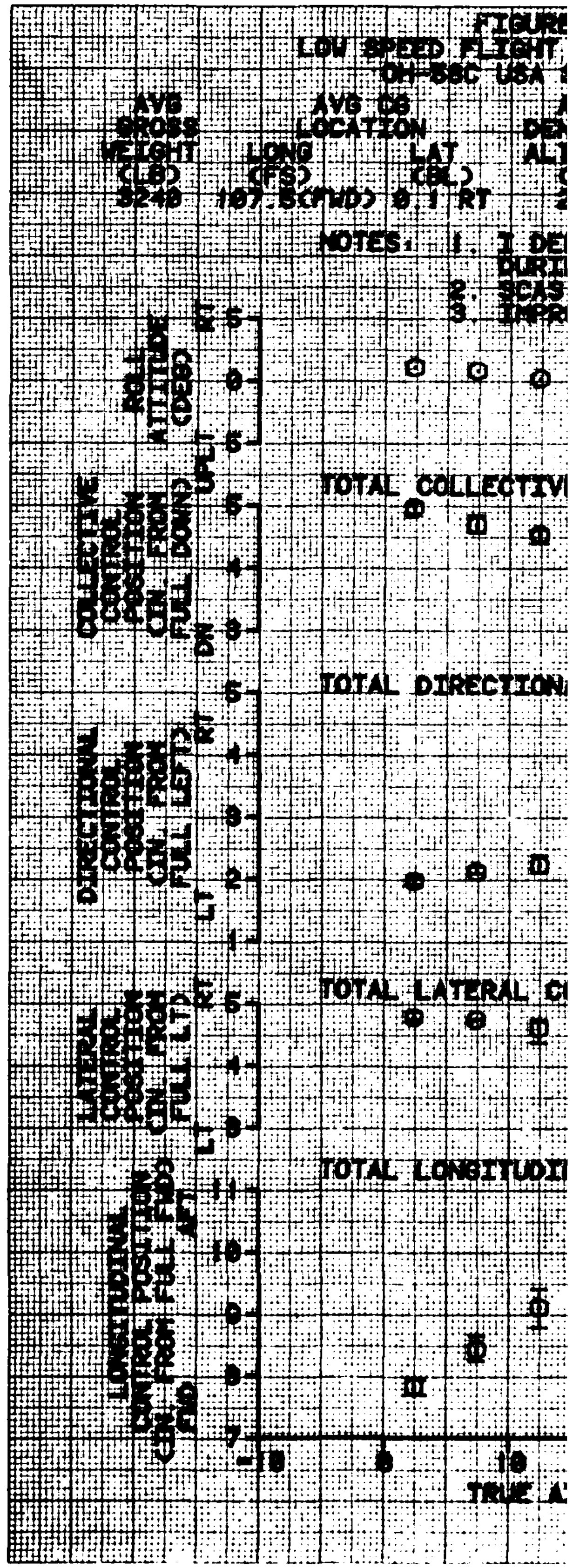


FIGURE 48
LOW SPEED FLIGHT 210 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3260
AVG CG LOCATION LONG (FS) 107.5(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2000
AVG OAT (DEG C) 27.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG)
NU
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.6 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
-10
0
10
20
30
40
50
TRUE AIRSPEED (KNOTS)
210 DEG. AZIMUTH





225 DEG. AZIMUTH
AVG
OAT
(DEG C)
23.5
AVG
ROTOR
SPEED
(RPM)
352
SKID
HEIGHT
(FT)
10
OTES MAXIMUM CONTROL EXCURSION
20 SECOND DATA RECORD
VED TAIL ROTOR
CONTROL TRAVEL = 10.0 INCHES
NTROL TRAVEL = 10.6 INCHES
AL CONTROL TRAVEL = 11.6 INCHES
20
30
40
50
RSPEED (KNOTS)
225 DEG. AZIMUTH



LOW SPEED FLIGHT
AVG
GROSS
WEIGHT
(LB)
3240
AVG CG
LOCATION
LONG
(FS)
107.5(FWD)
LAT
(BL)
0.1 RT
NOTES:
ROLL ATTITUDE (DEG)
TOTAL COLLECTIV
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTION
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL C
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDI
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TRUE A

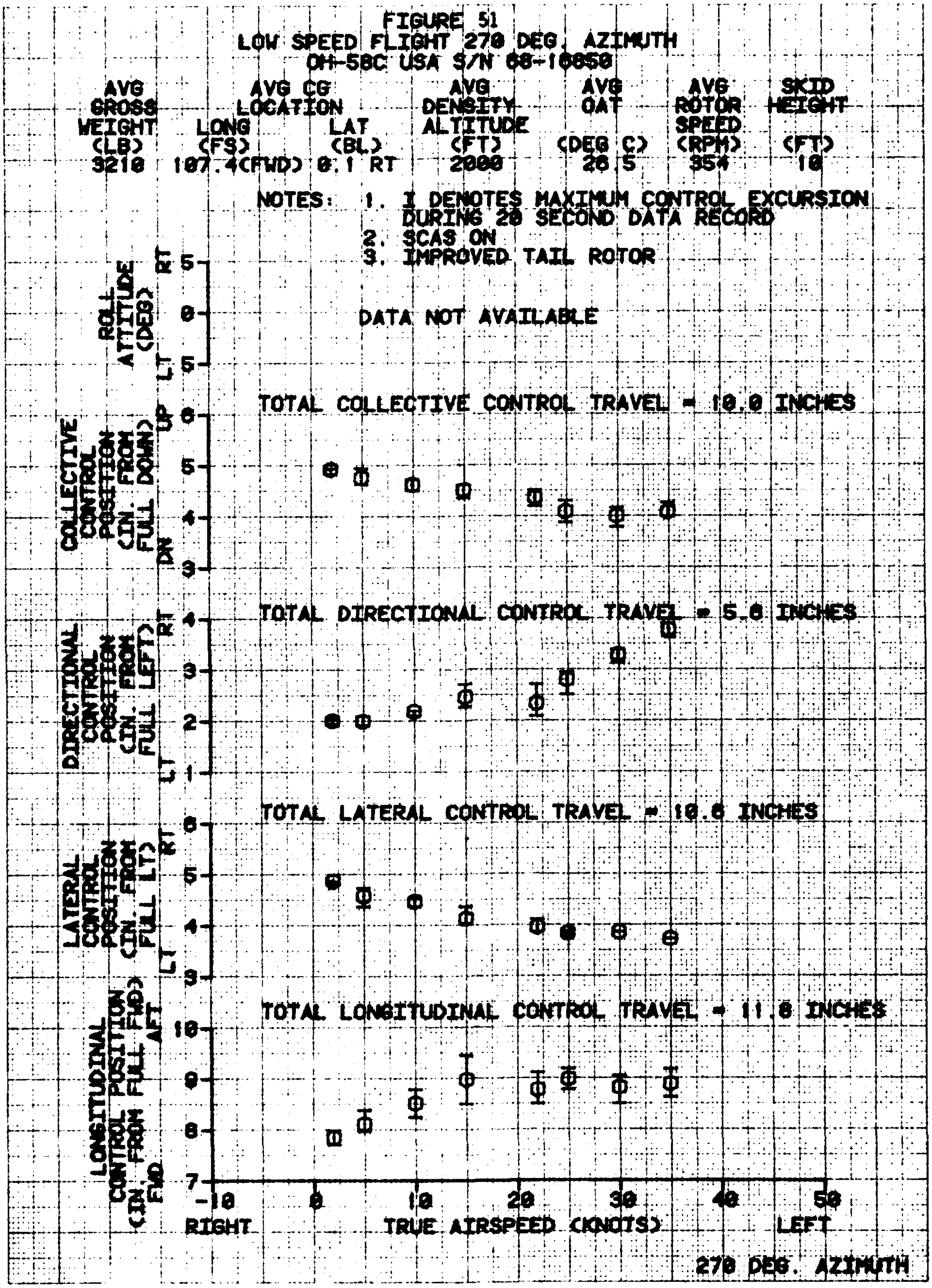


FIGURE 51
LOW SPEED FLIGHT 270 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3210
AVG CG LOCATION LONG (FS) 107.4(FWD) LAT (BL) 0.1 RT
AVG DENSITY ALTITUDE (FT) 2000
AVG OAT (DEG C) 26.5
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
DATA NOT AVAILABLE
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
270 DEG. AZIMUTH

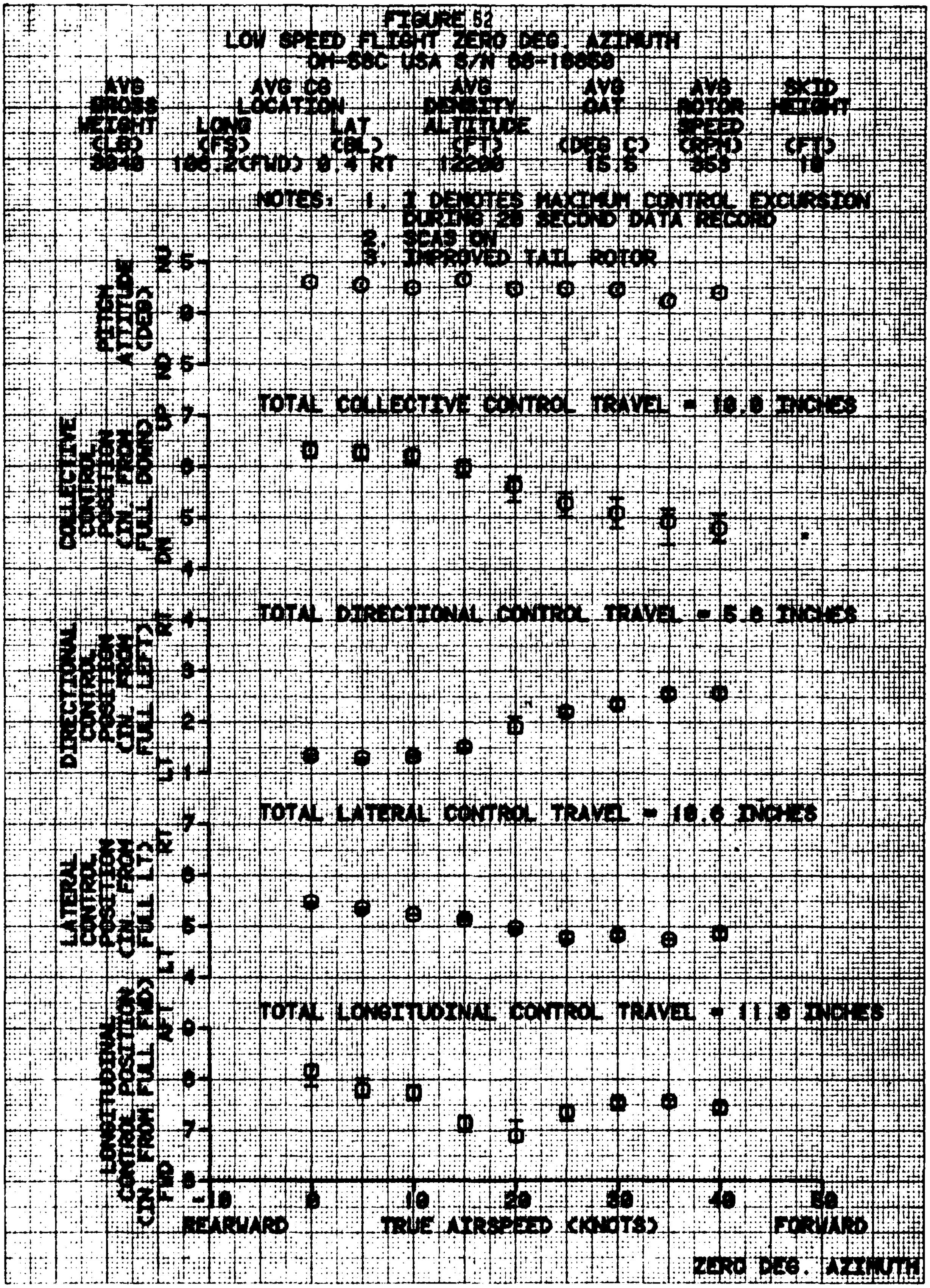


FIGURE 52
LOW SPEED FLIGHT ZERO DEG. AZIMUTH
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
SKID HEIGHT (FT)
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
PITCH ATTITUDE (DEG)
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
REARWARD
TRUE AIRSPEED (KNOTS)
FORWARD
ZERO DEG. AZIMUTH

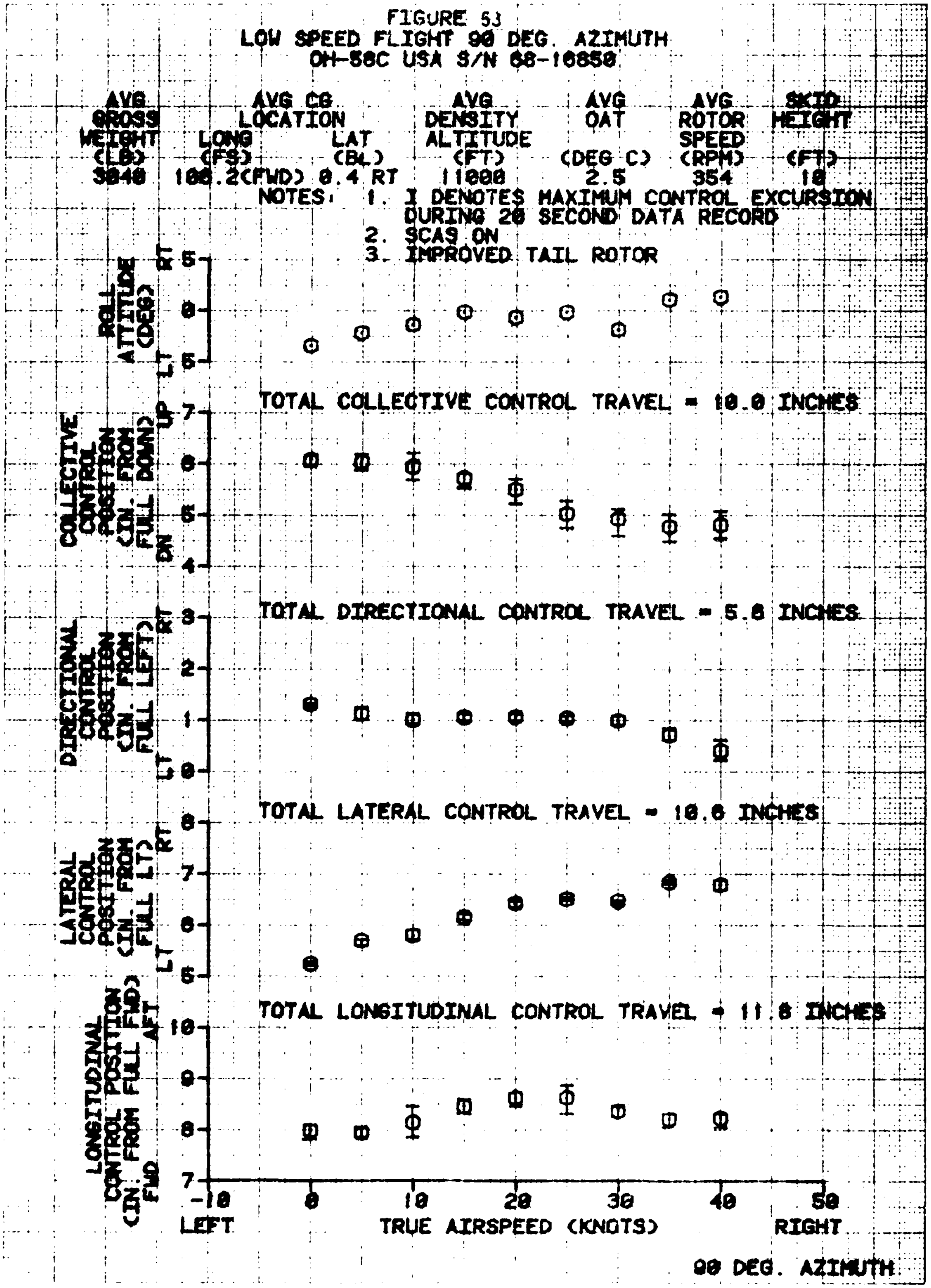
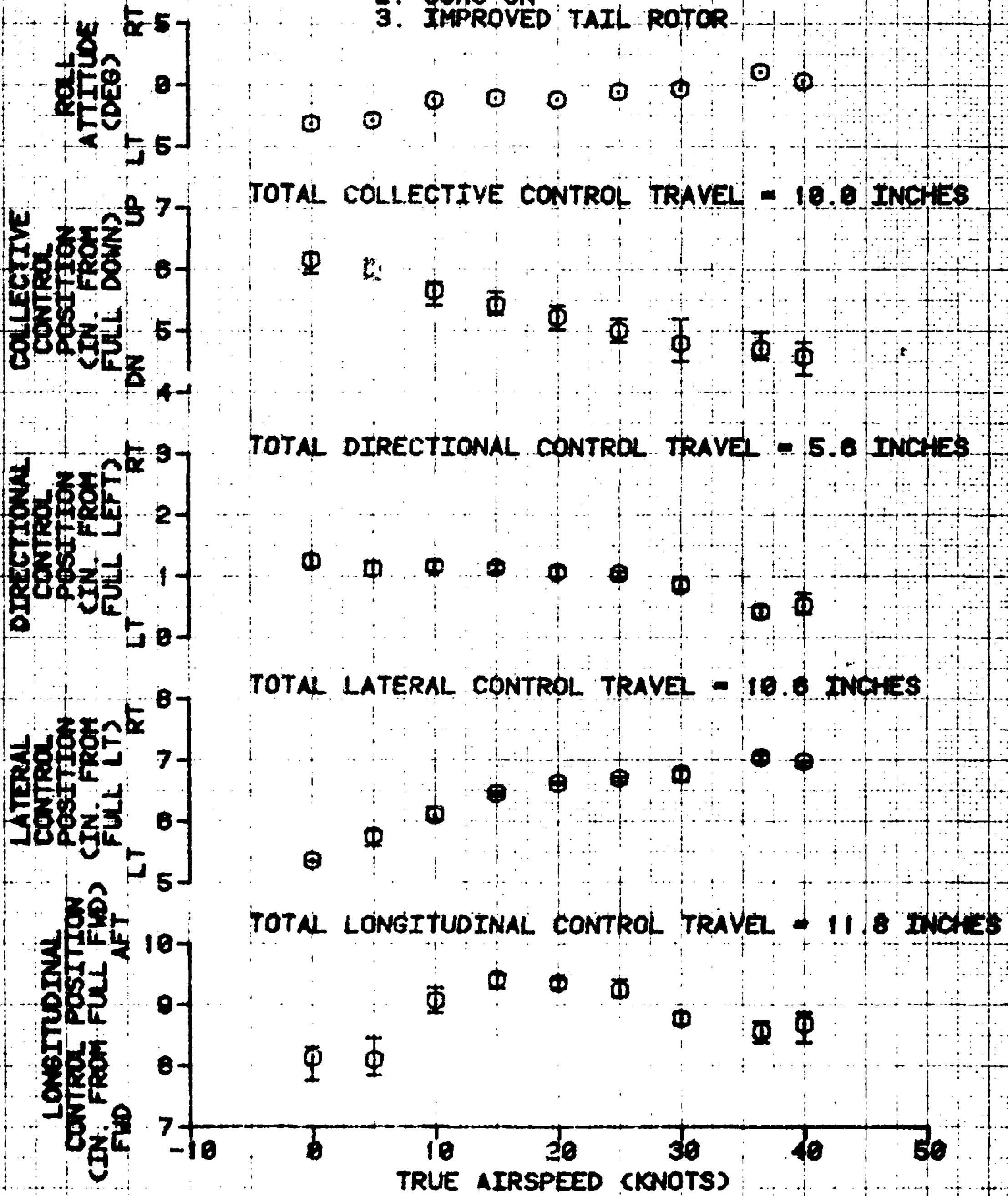


FIGURE 53
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3040
AVG CG LOCATION LONG (FS) 106.2(FWD) LAT (BL) 0.4 RT
AVG DENSITY ALTITUDE (FT) 11000
AVG OAT (DEG C) 2.5
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.6 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
LEFT
TRUE AIRSPEED (KNOTS)
RIGHT
90 DEG. AZIMUTH

FIGURE 54
LOW SPEED FLIGHT 120 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
2940	106.0(FWD)	0.4 RT	10750	5.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR

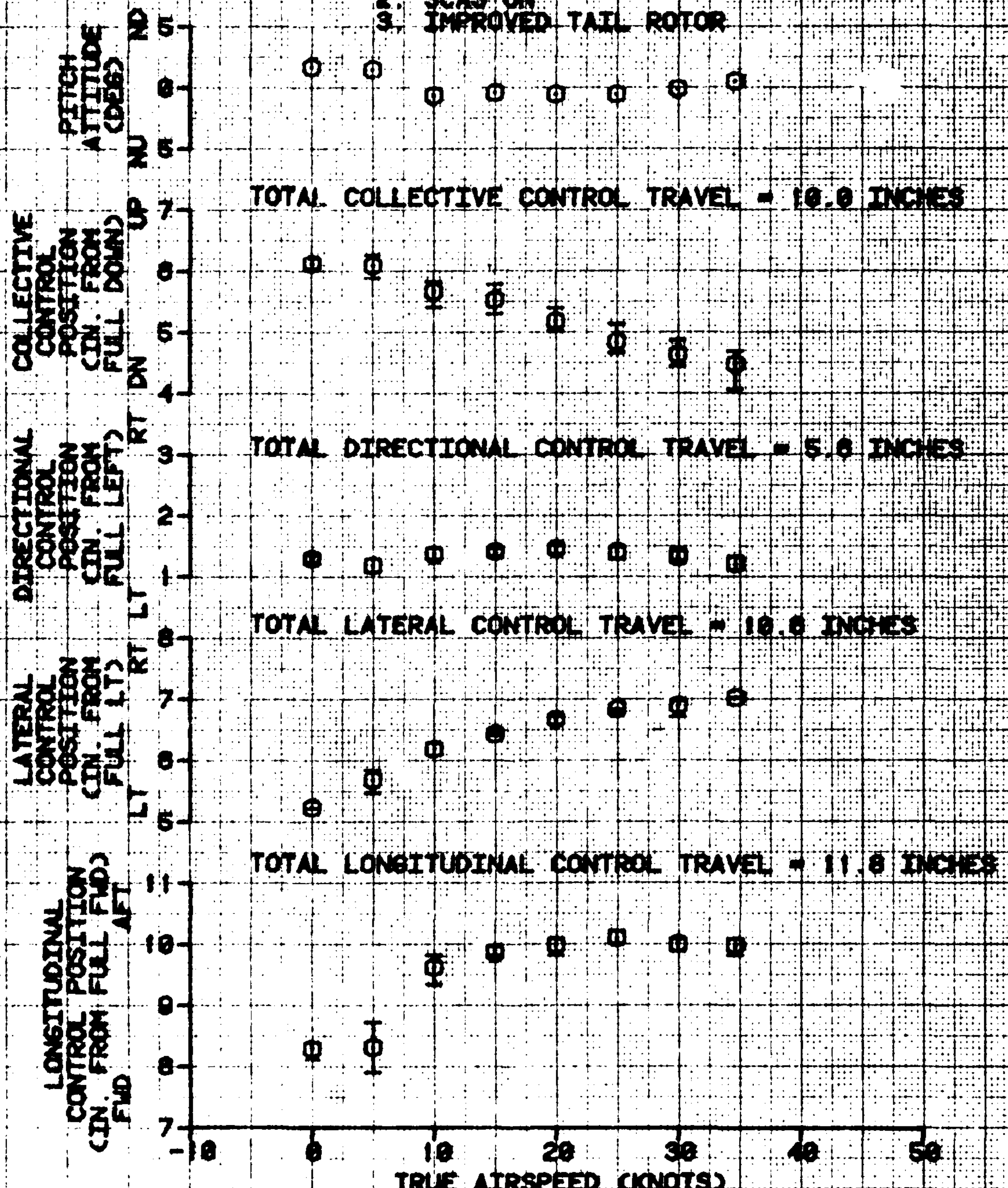


120 DEG. AZIMUTH

FIGURE 55
LOW SPEED FLIGHT 150 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
2970	106.1(FWD)	0.4 RT	10750	5.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR

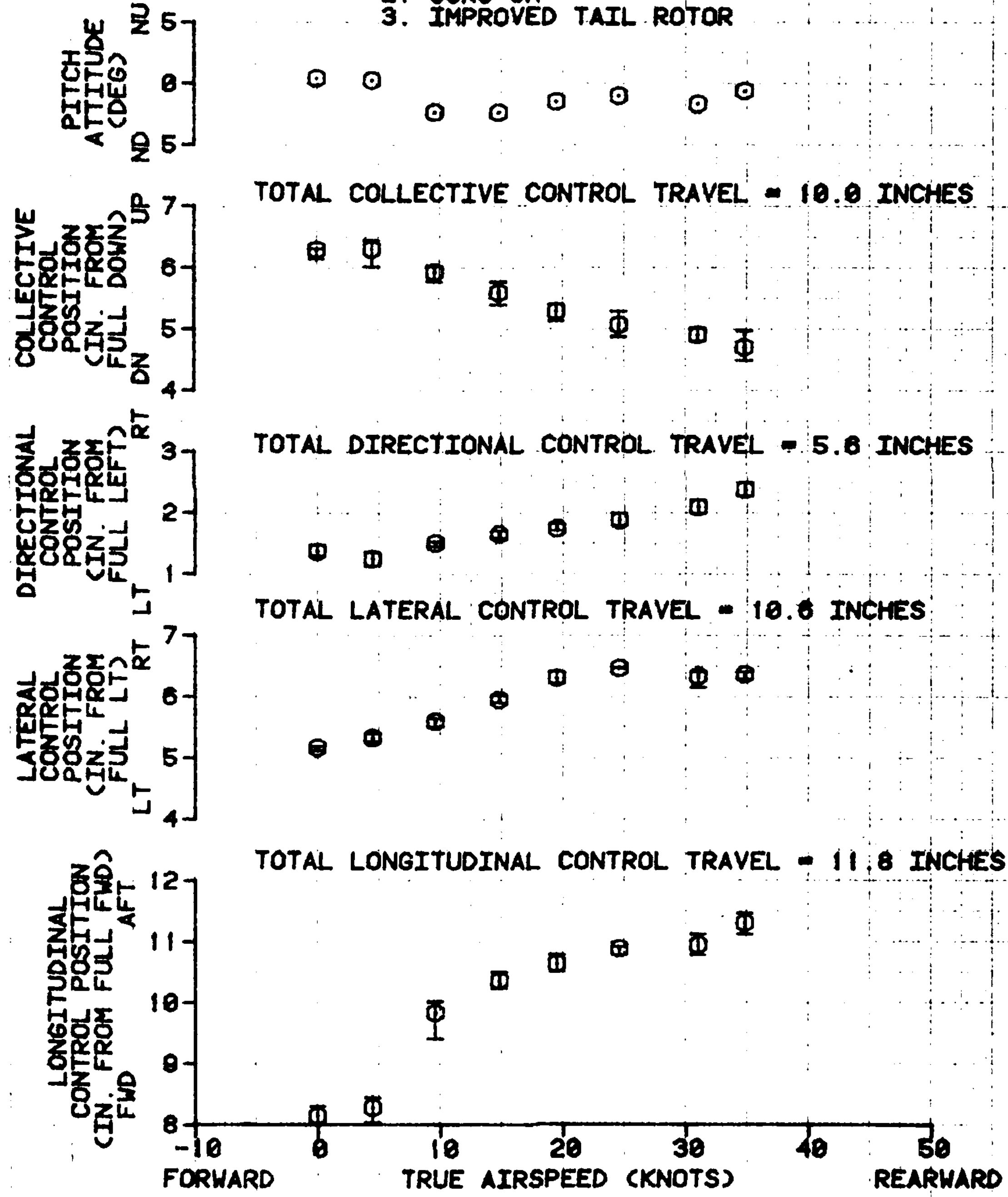


150 DEG. AZIMUTH

FIGURE 56
LOW SPEED FLIGHT 180 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3040	106.2(FWD)	0.4 RT	11000	2.0	351	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR

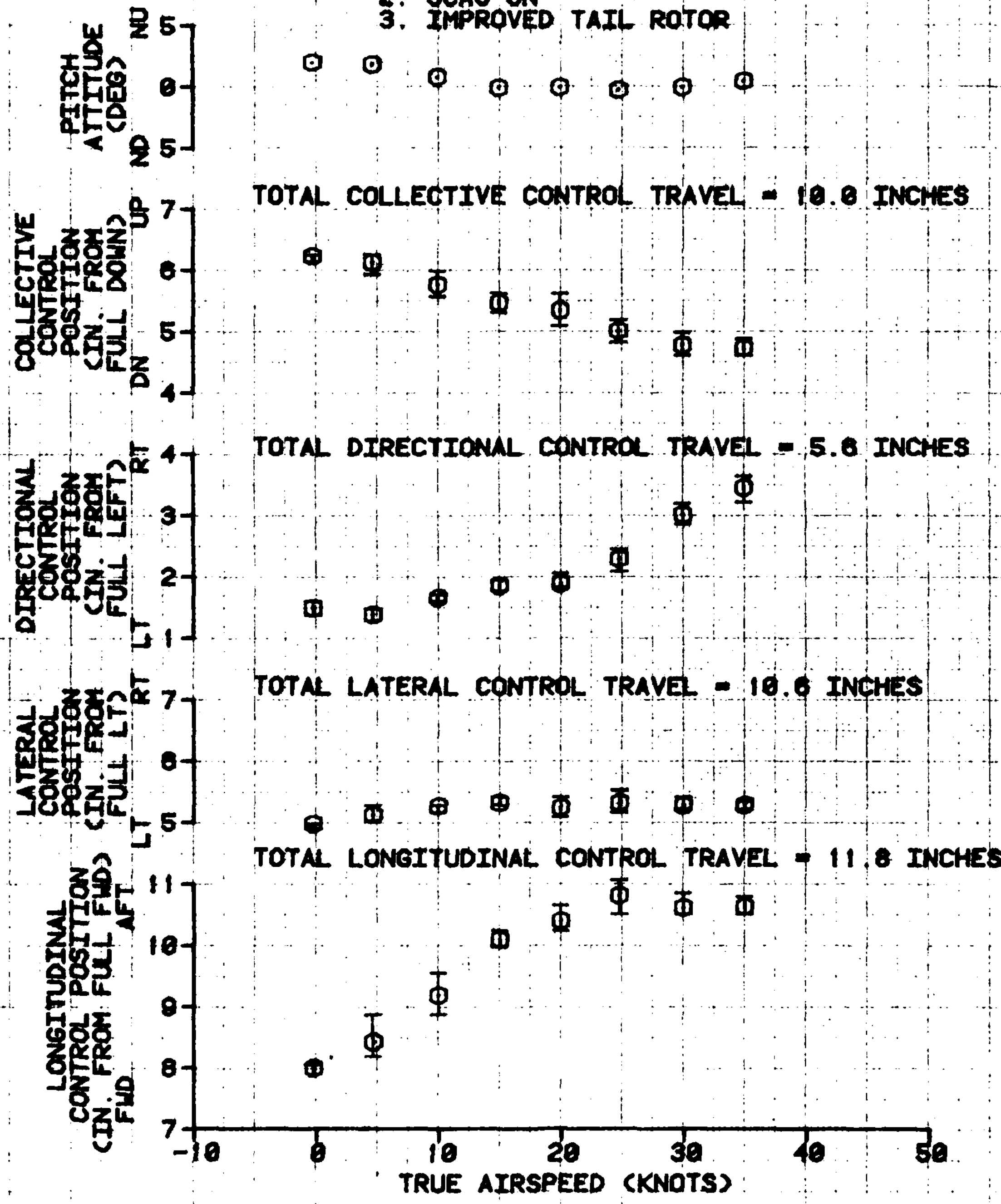


180 DEG. AZIMUTH

FIGURE 57
LOW SPEED FLIGHT 210 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
2980	106.1(FWD)	0.4 RT	11000	2.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR

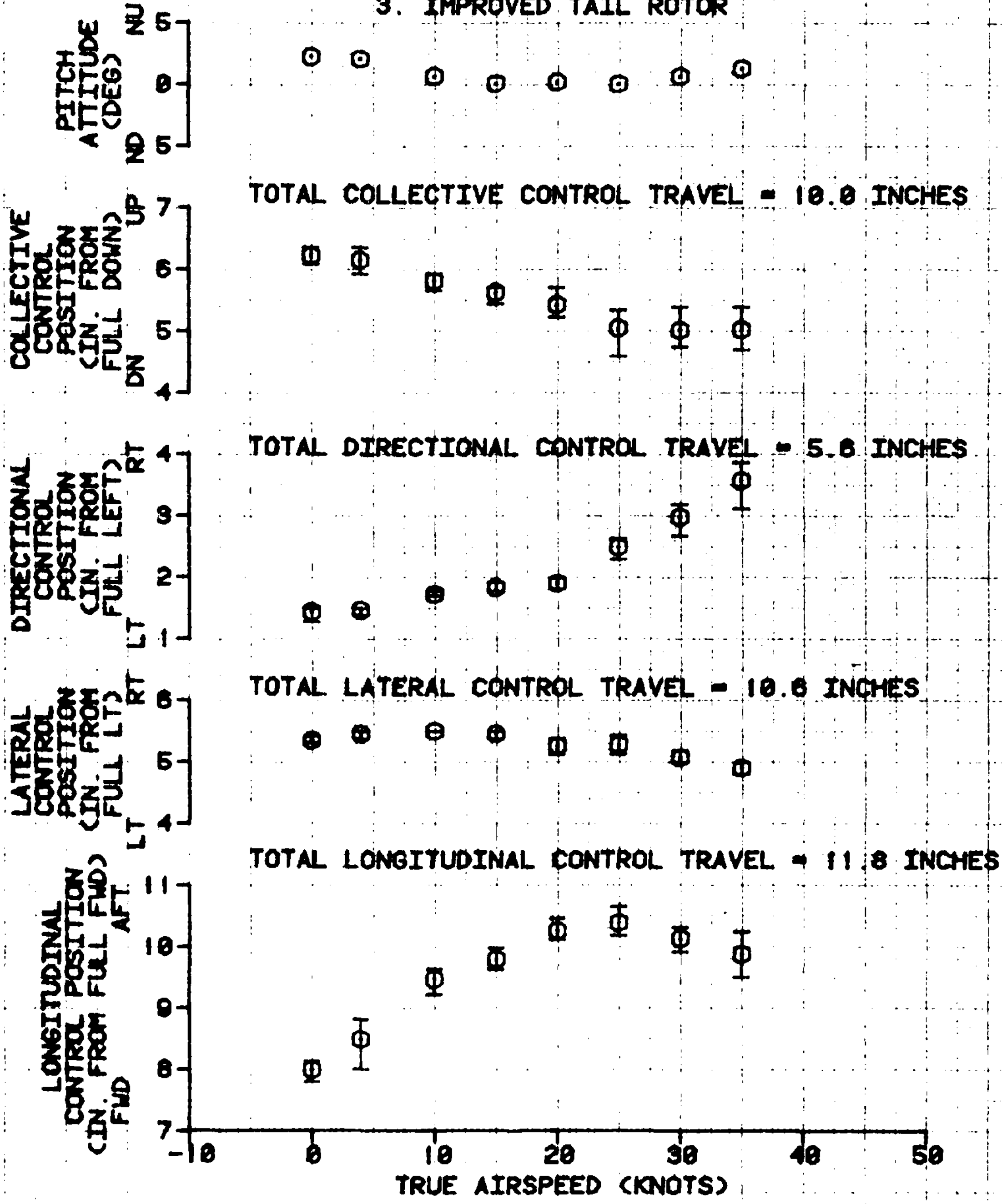


210 DEG. AZIMUTH

FIGURE 58
LOW SPEED FLIGHT 225 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
2980	106.1(FWD)	0.4 RT	12200	15.5	353	10

NOTES:
1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR



225 DEG. AZIMUTH

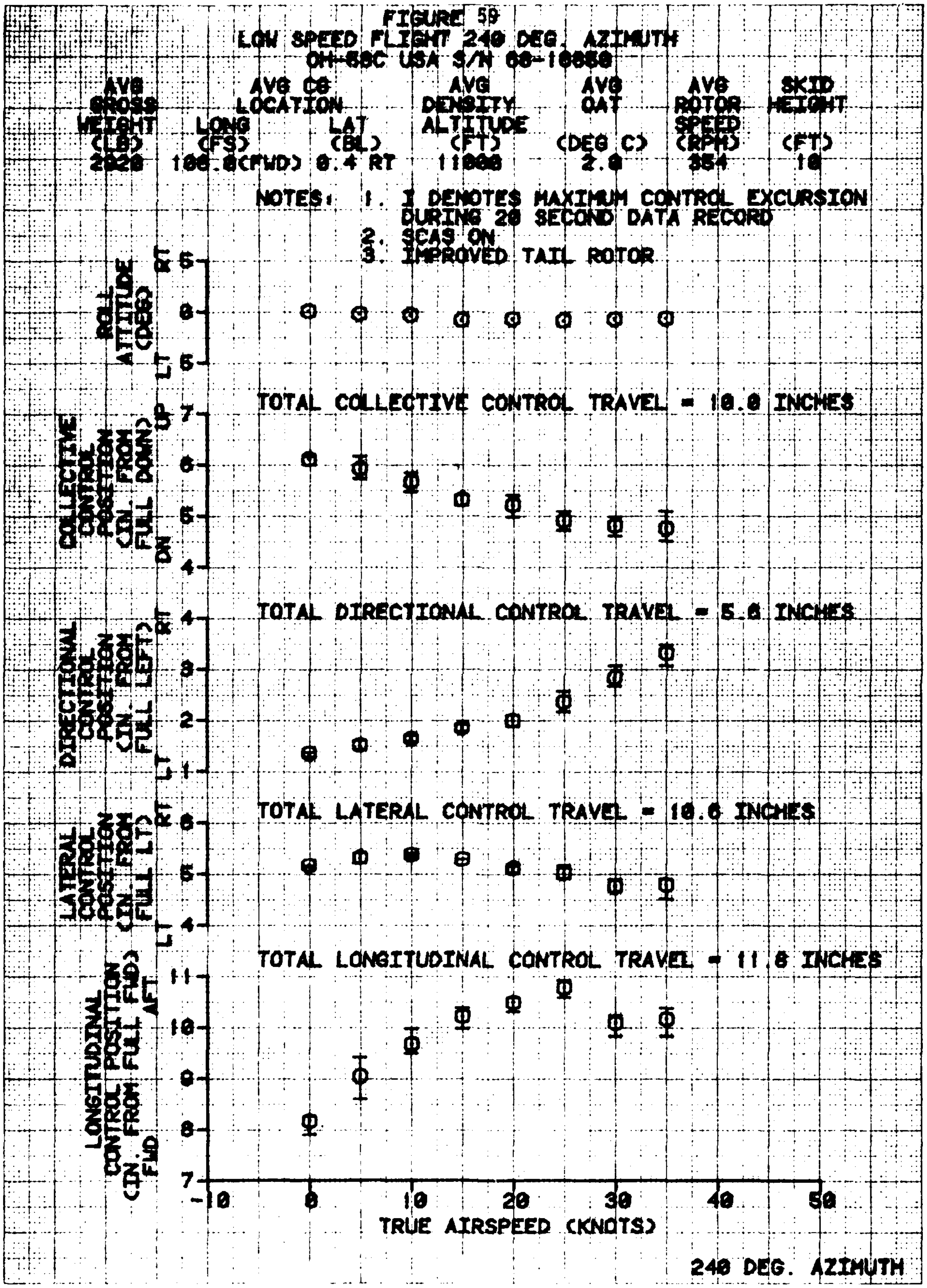


FIGURE 59
LOW SPEED FLIGHT 240 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 2920
AVG CG LOCATION LONG (FS) 106.8(FWD) LAT (BL) 0.4 RT
AVG DENSITY ALTITUDE (FT) 11000
AVG OAT (DEG C) 2.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
TRUE AIRSPEED (KNOTS)
240 DEG. AZIMUTH

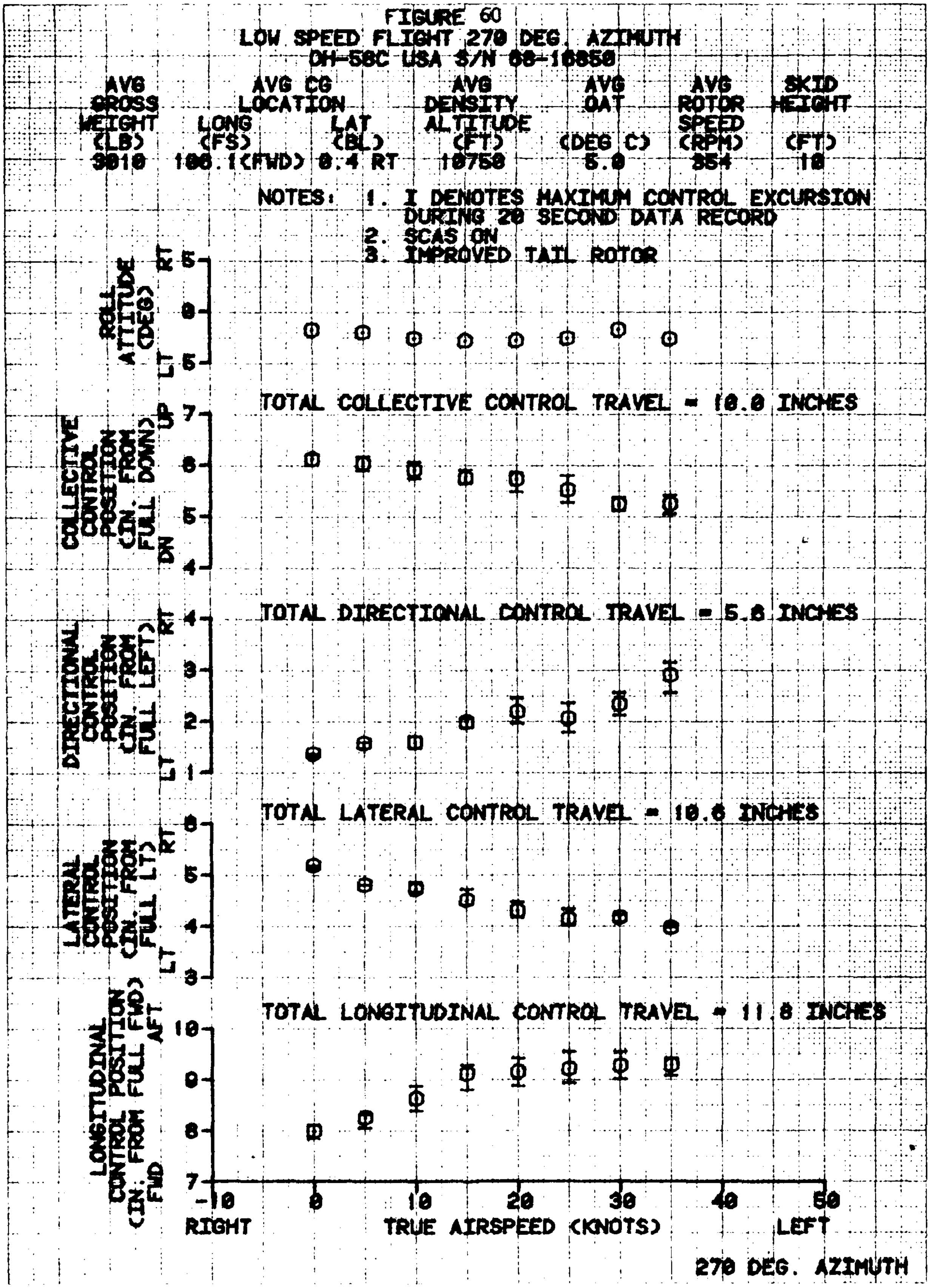
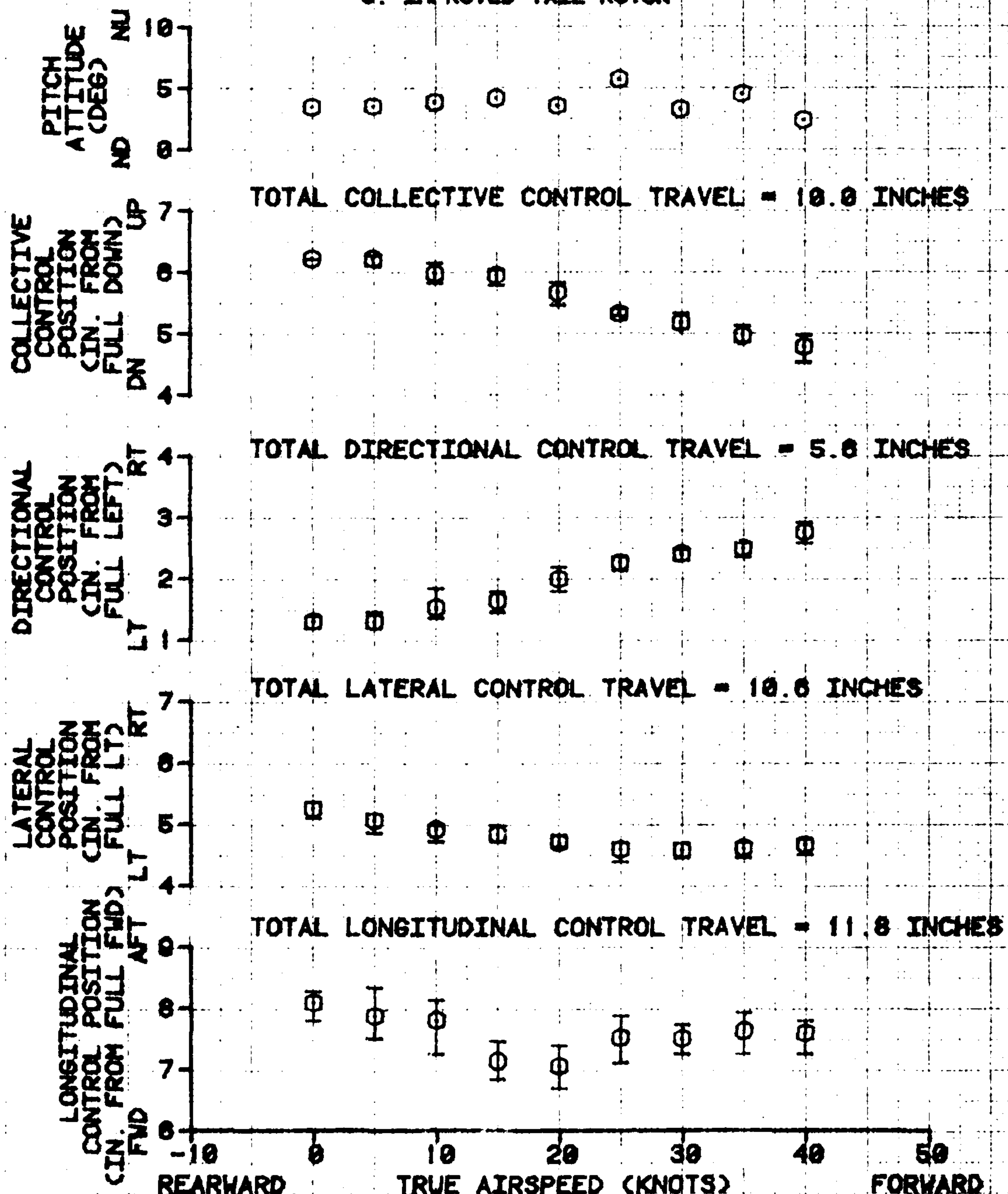


FIGURE 60
LOW SPEED FLIGHT 270 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3010
AVG CG LOCATION LONG (FS) 106.1(FWD) LAT (BL) 0.4 RT
AVG DENSITY ALTITUDE (FT) 10750
AVG OAT (DEG C) 5.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
270 DEG. AZIMUTH

FIGURE 61
LOW SPEED FLIGHT ZERO DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3000	106.5(FWD)	0.3 LT	11400	13.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. IMPROVED TAIL ROTOR



ZERO DEG. AZIMUTH

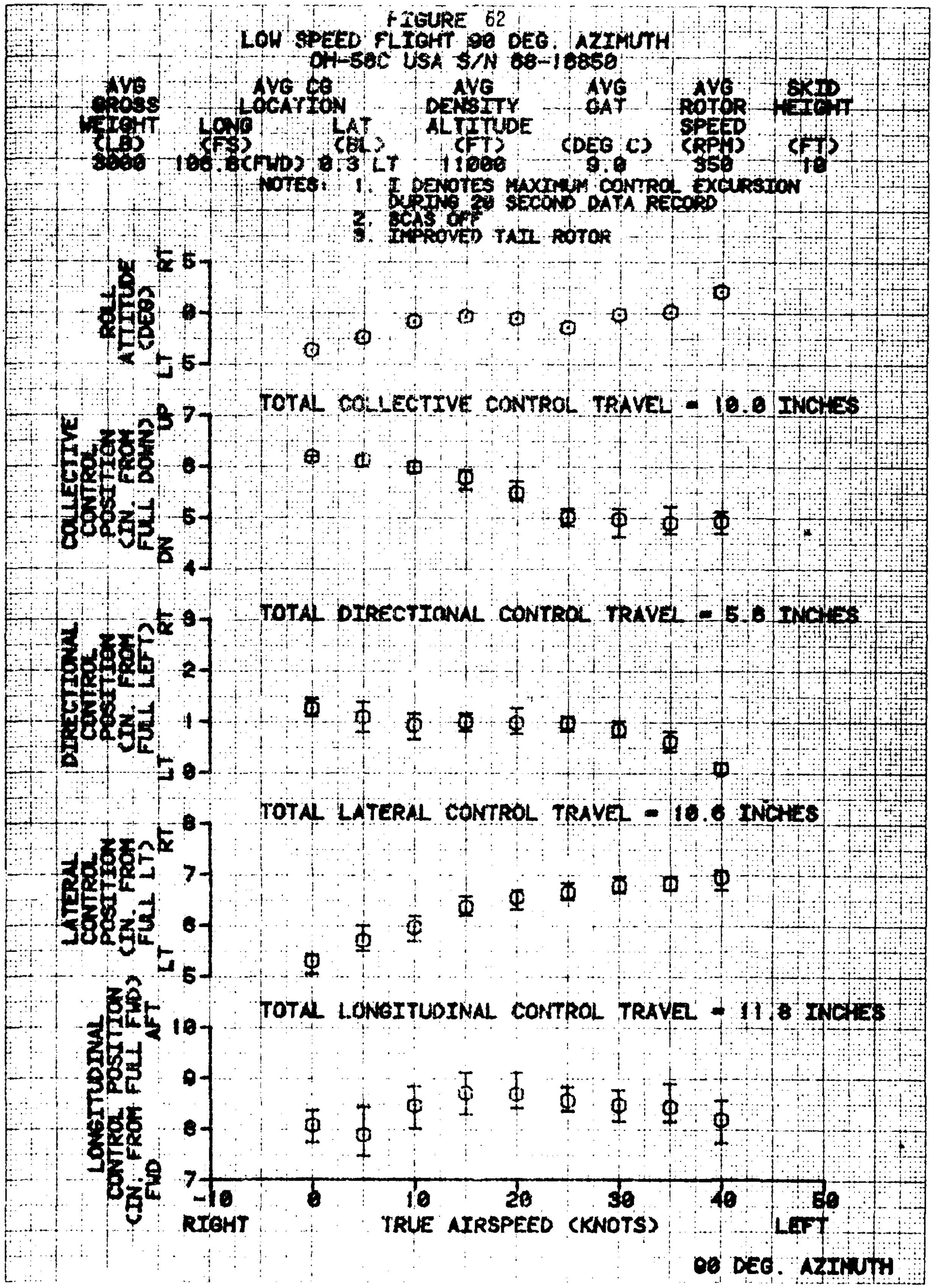
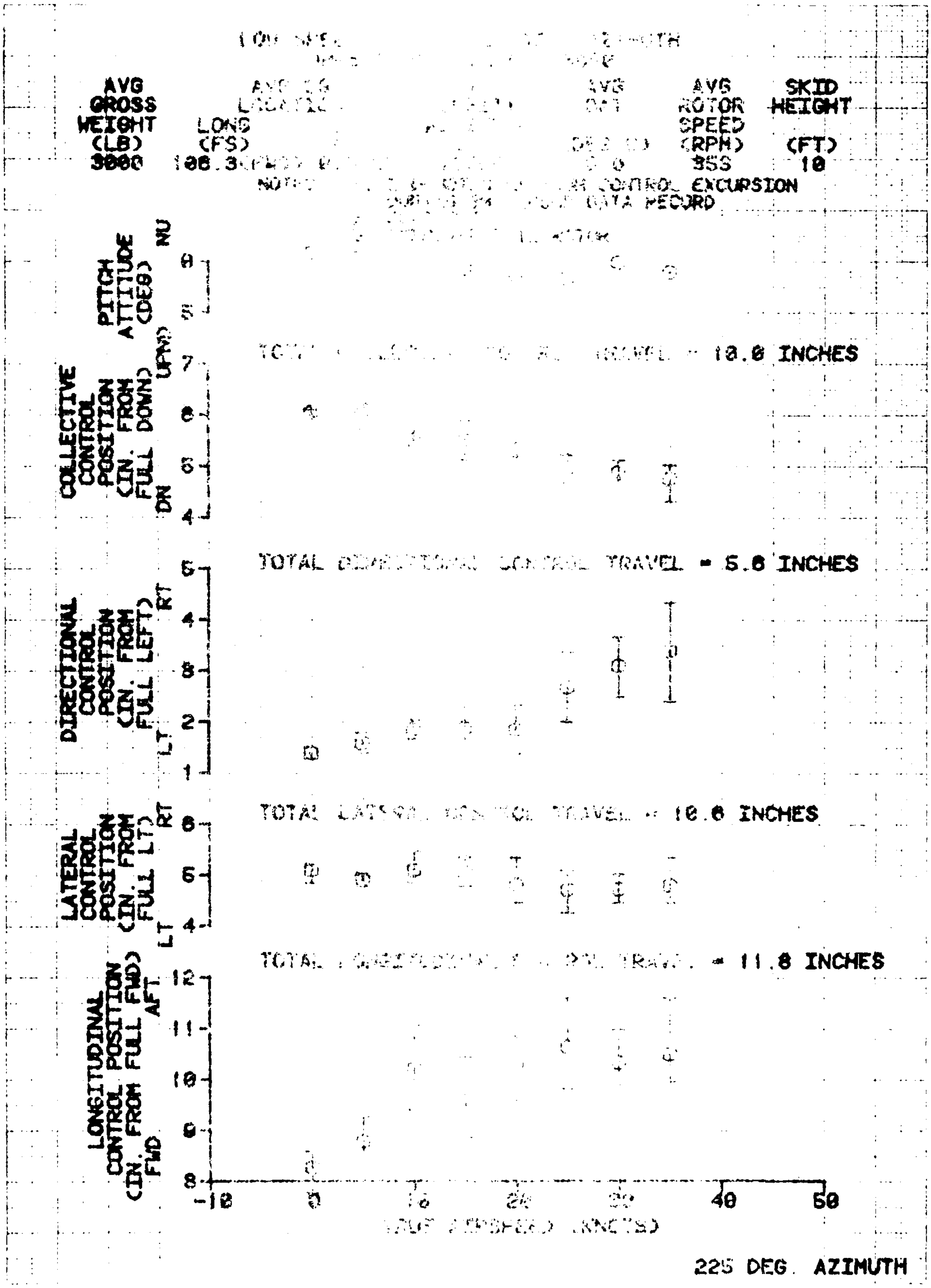


FIGURE 62
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3000
AVG CG LOCATION LONG (FS) 106.8(FWD) LAT (BL) 0.3 LT
AVG DENSITY ALTITUDE (FT) 11000
AVG OAT (DEG C) 9.0
AVG ROTOR SPEED (RPM) 350
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
LT
RT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
DN
UP
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
FWD
AFT
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
90 DEG. AZIMUTH



AVG GROSS WEIGHT (LB) 3000
LONG (FS) 106.3
AVG ROTOR SPEED (RPM) 355
SKID HEIGHT (FT) 10
CONTROL EXCURSION
DATA RECORD
PITCH ATTITUDE (DEG) NU
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN) UP DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.0 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT) RT LT
TOTAL LATERAL CONTROL TRAVEL = 10.0 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT) RT LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.0 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD) AFT FWD
-10
0
10
20
30
40
50
(KNOTS)
225 DEG. AZIMUTH

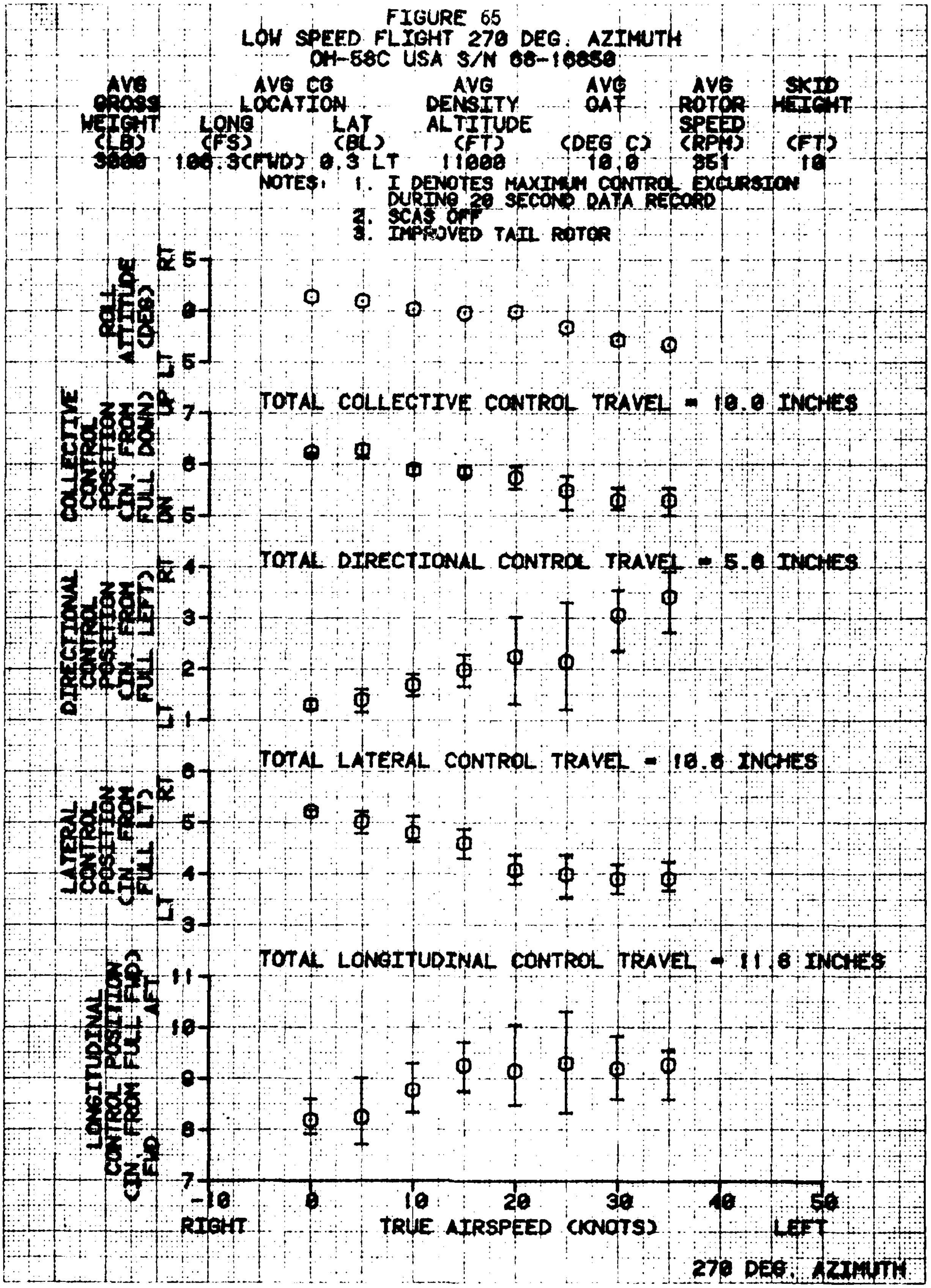
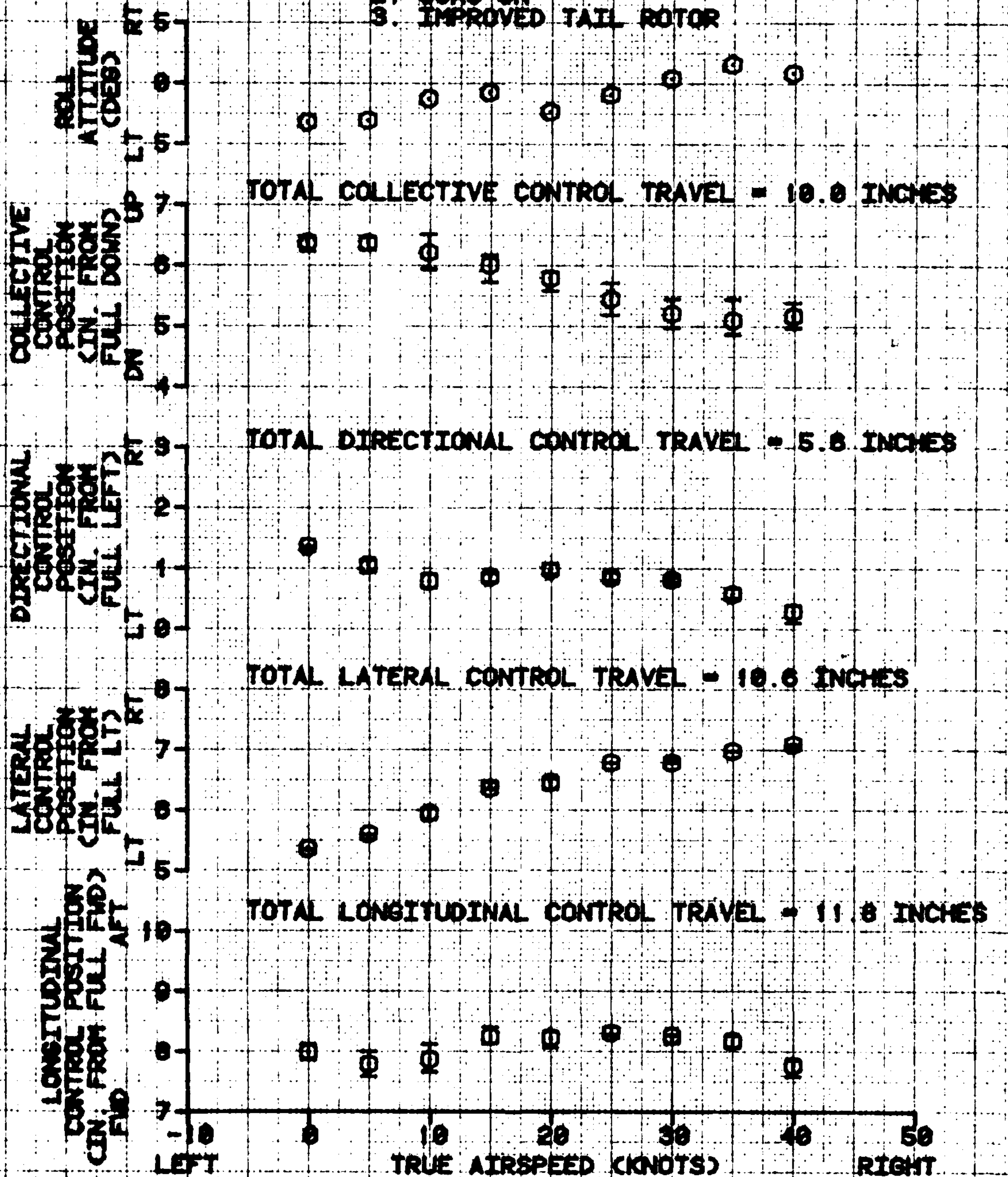


FIGURE 65
LOW SPEED FLIGHT 270 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3000
AVG CG LOCATION LONG (FS) 106.3(FWD) LAT (BL) 0.3 LT
AVG DENSITY ALTITUDE (FT) 11000
AVG OAT (DEG C) 10.0
AVG ROTOR SPEED (RPM) 351
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. IMPROVED TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
-10 0 10 20 30 40 50
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
270 DEG. AZIMUTH

FIGURE 55
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
2900	106.8(FWD)	0.4 RT	11500	13.5	346	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR

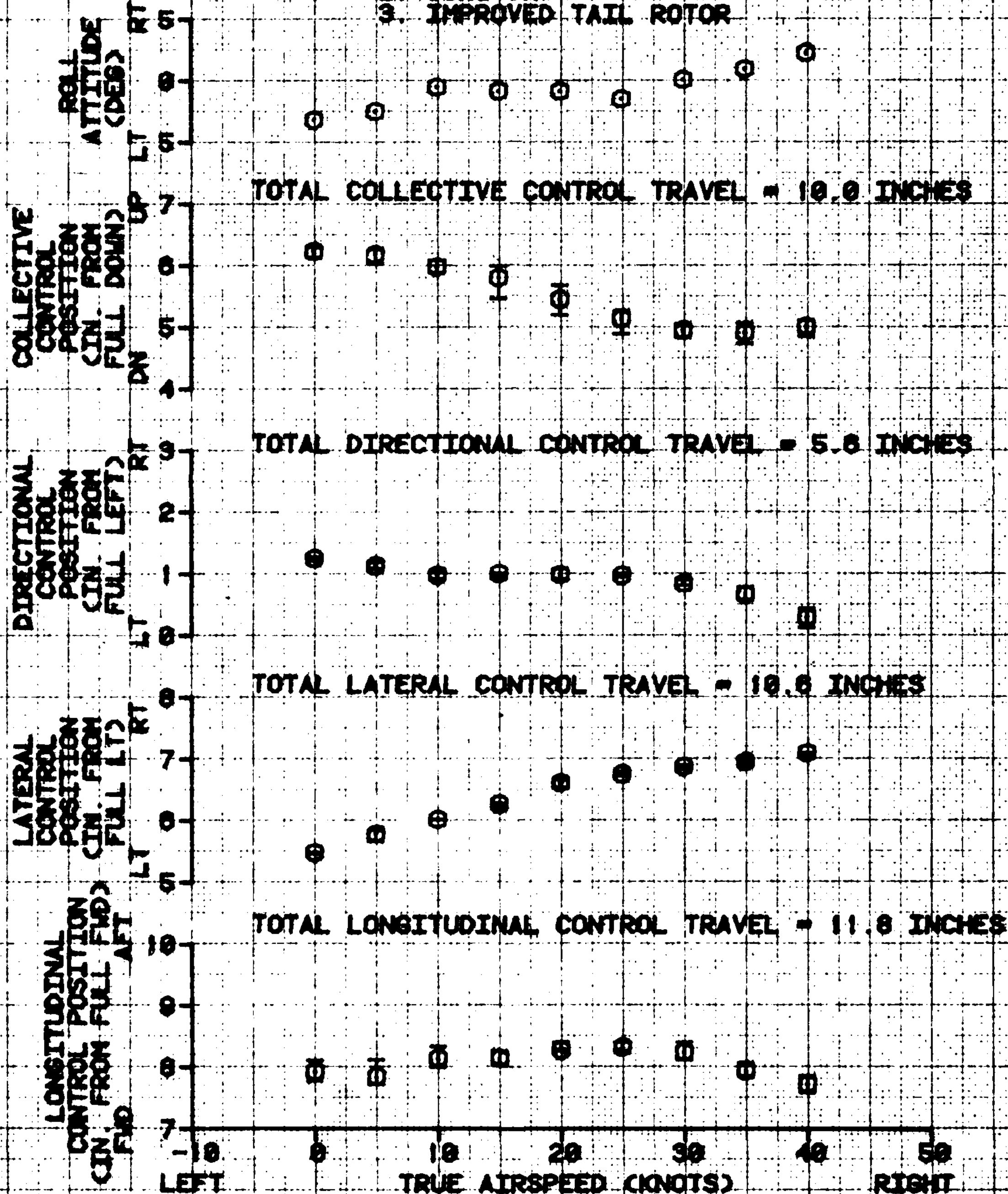


90 DEG. AZIMUTH

FIGURE 67
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3030	106.3(FWD)	0.4 RT	11500	13.5	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. IMPROVED TAIL ROTOR



90 DEG. AZIMUTH

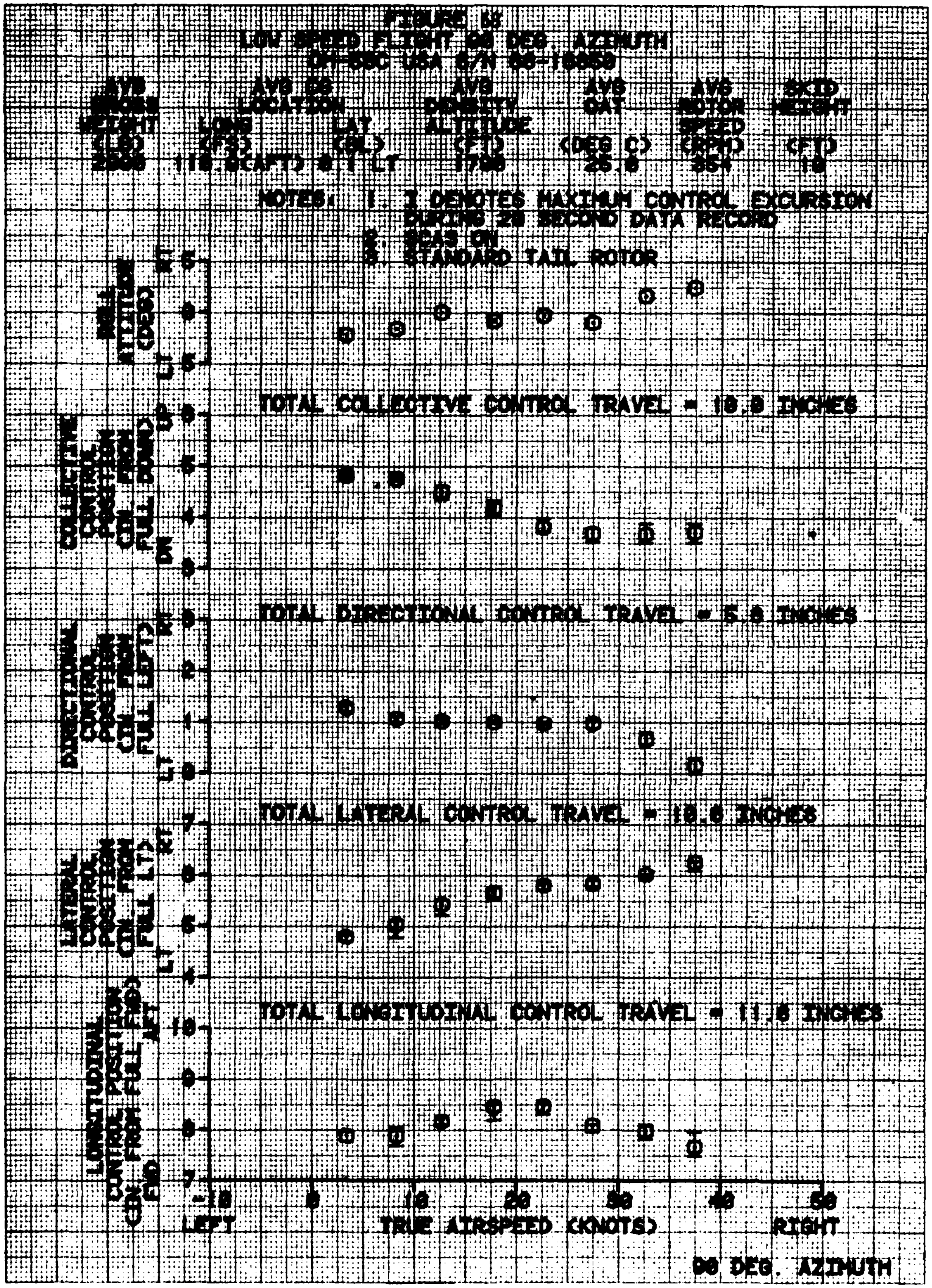
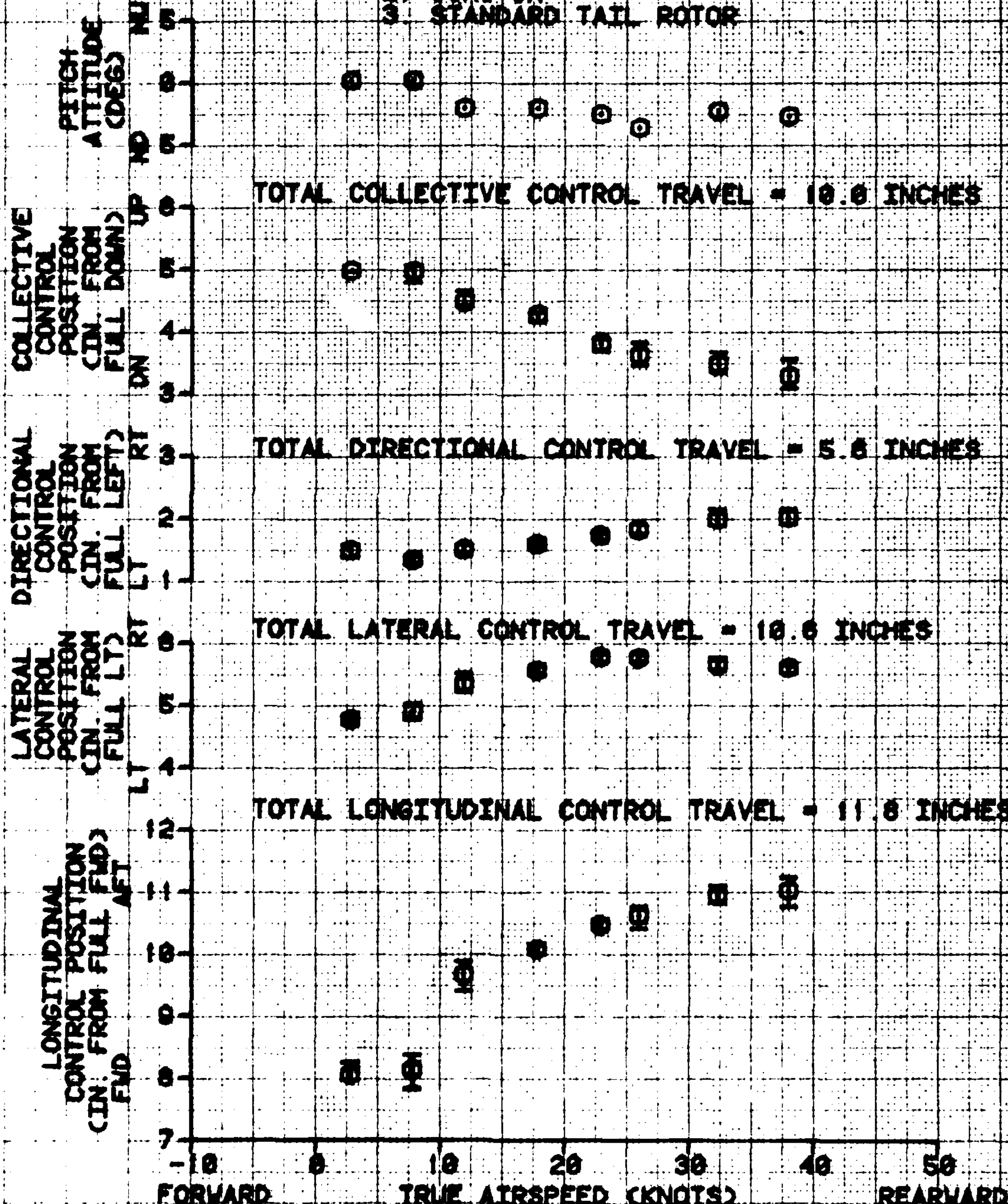

LOW SPEED FLIGHT 90 DEG. AZIMUTH
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
SKID HEIGHT (FT)
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR
ROLL ATTITUDE (DEG)
TOTAL COLLECTIVE CONTROL TRAVEL
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTIONAL CONTROL TRAVEL
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
-10 0 10 20 30 40 50
LEFT
TRUE AIRSPEED (KNOTS)
RIGHT
90 DEG. AZIMUTH

FIGURE 69
LOW SPEED FLIGHT 180 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3030	111.0(AFT)	0.1 LT	1680	25.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR



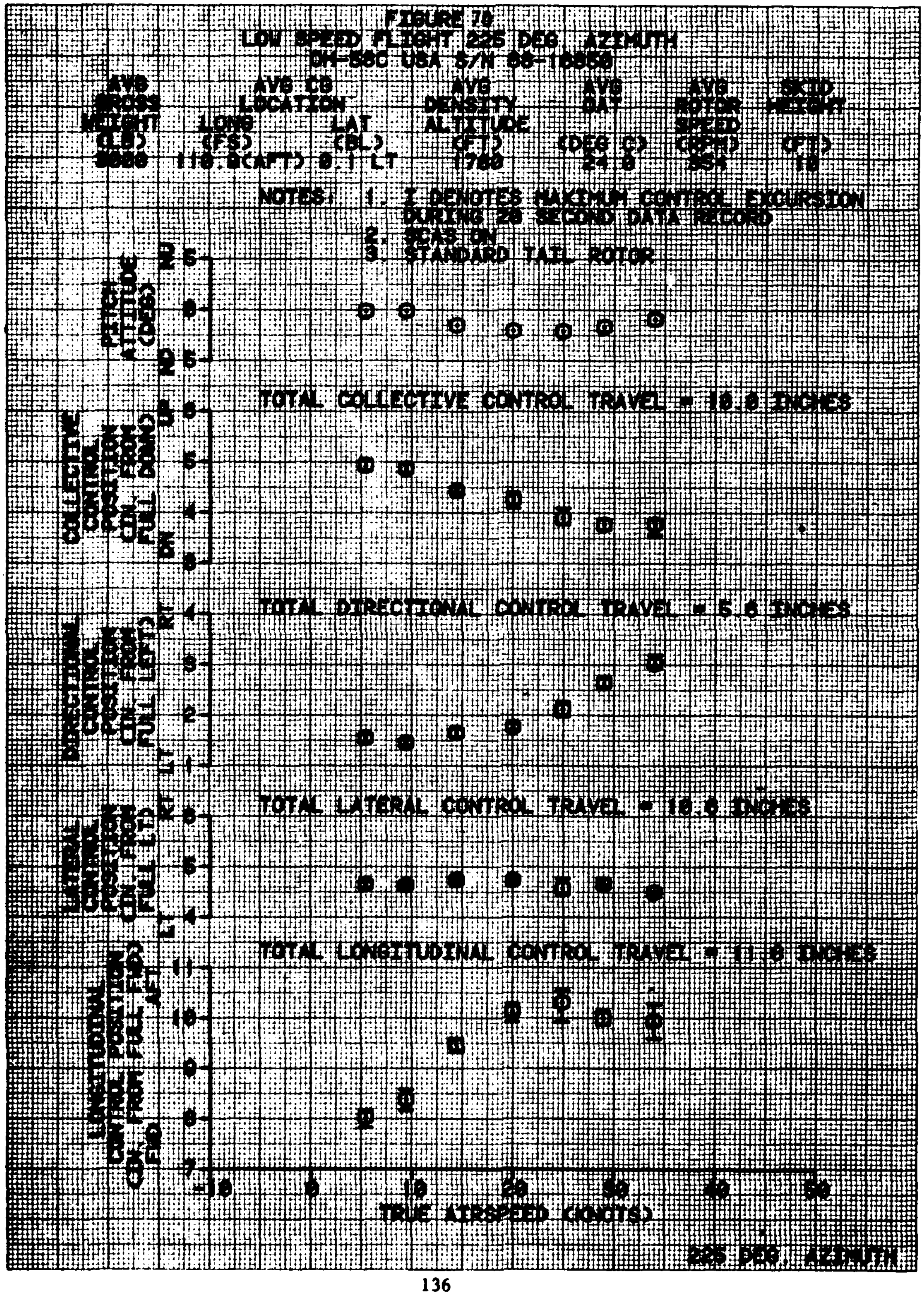
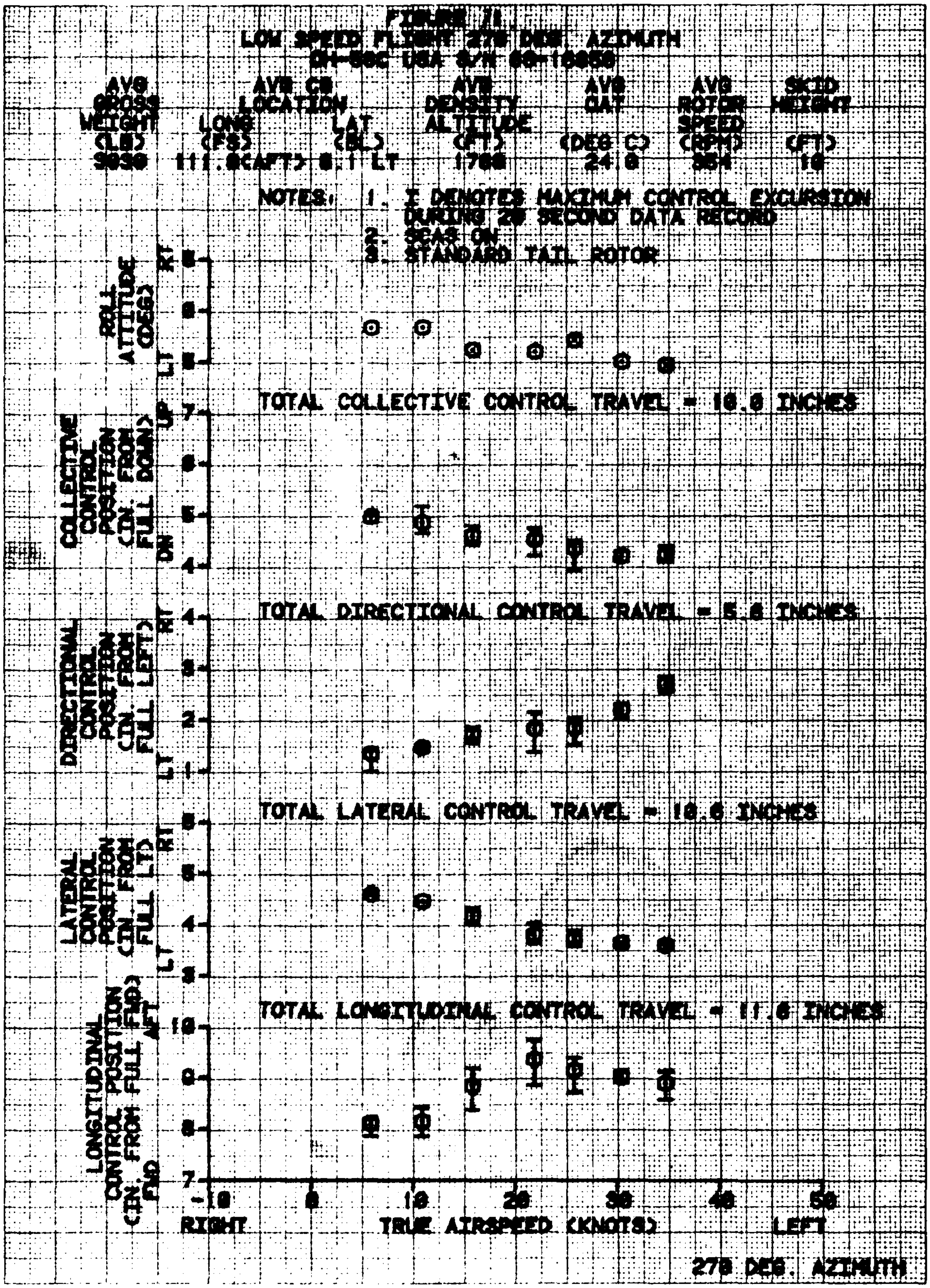


FIGURE 78
LOW SPEED FLIGHT 225 DEG AZIMUTH
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
SKID HEIGHT (FT)
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR
PITCH ATTITUDE (DEG)
TOTAL COLLECTIVE CONTROL TRAVEL
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
TOTAL DIRECTIONAL CONTROL TRAVEL
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL
LONGITUDINAL CONTROL POSITION (IN. FROM FULL AFT)
TRUE AIRSPEED (KNOTS)
225 DEG AZIMUTH



LOW SPEED FLIGHT 270 DEG. AZIMUTH
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
SKID HEIGHT (FT)
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL
INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL
INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL
INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL
INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
270 DEG. AZIMUTH

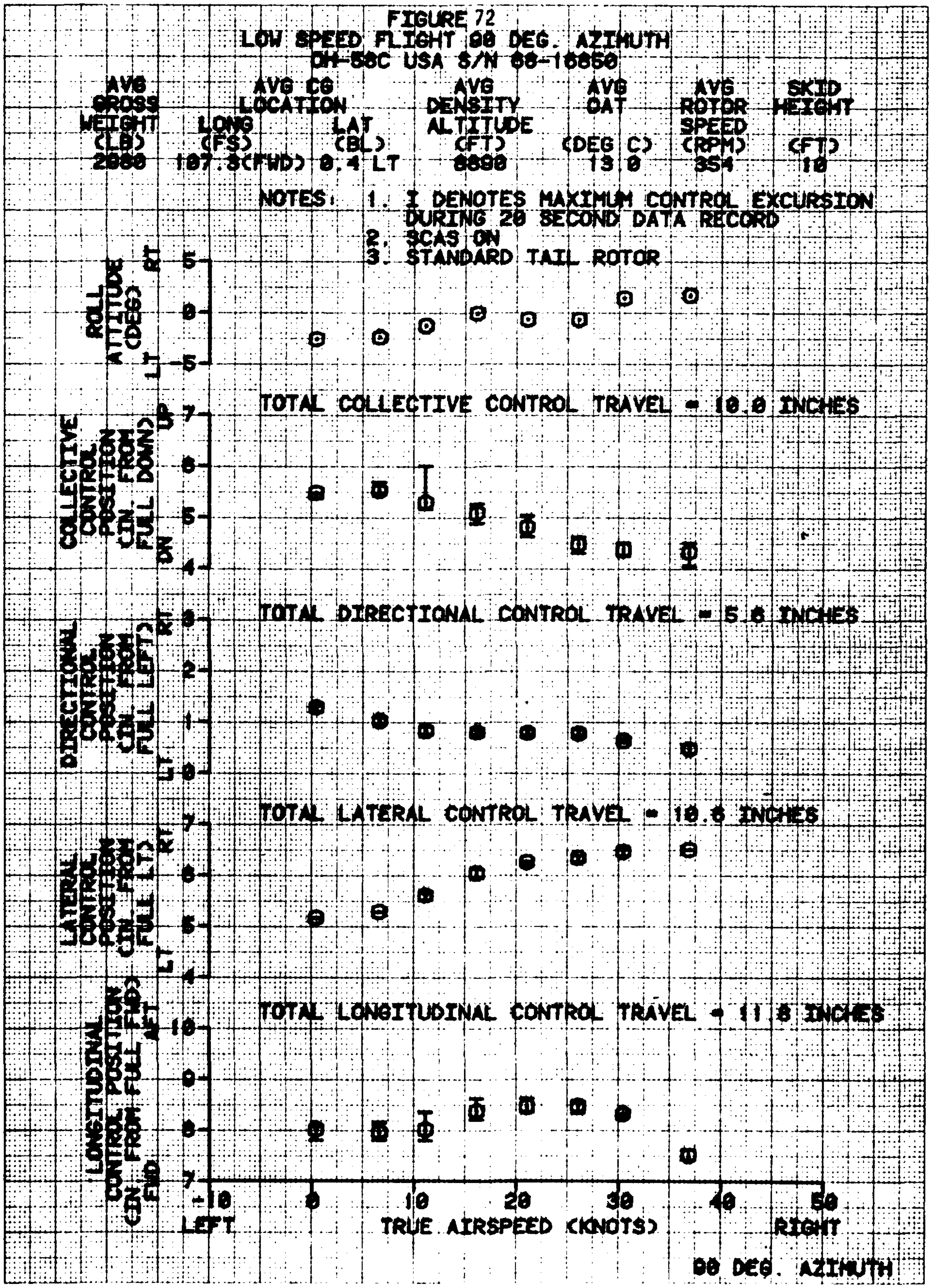
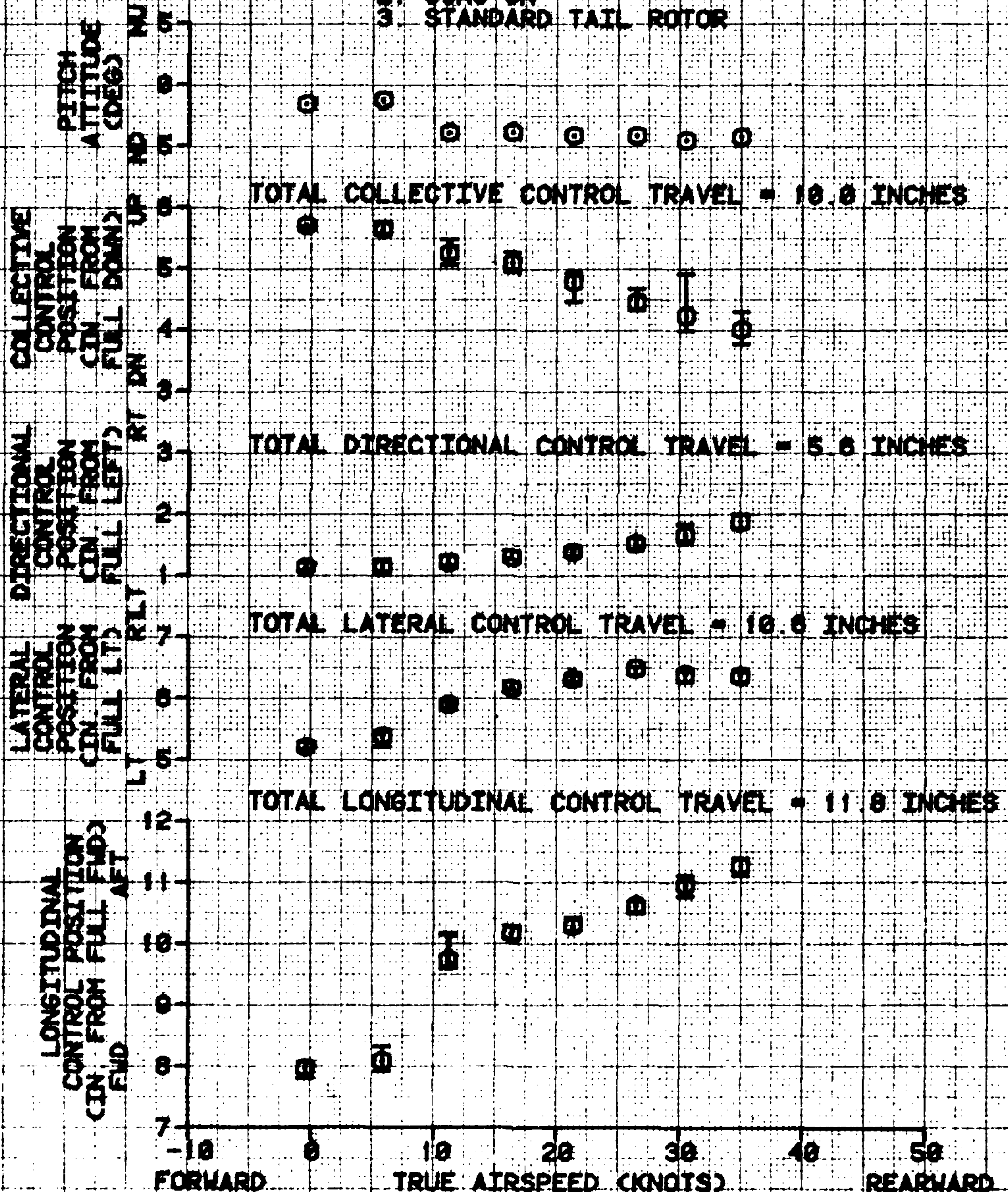


FIGURE 72
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 2980
AVG CG LOCATION LONG (FS) 107.3(FWD) LAT (BL) 0.4 LT
AVG DENSITY ALTITUDE (FT) 8890
AVG OAT (DEG C) 13.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
5
0
-5
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
7
6
5
4
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.6 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
RT
LT
3
2
1
0
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
RT
LT
7
6
5
4
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.6 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
10
9
8
7
-10
0
10
20
30
40
50
LEFT
TRUE AIRSPEED (KNOTS)
RIGHT
90 DEG. AZIMUTH

FIGURE 73
LOW SPEED FLIGHT 180 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3030	107.3(FWD)	0.4 LT	8080	11.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR

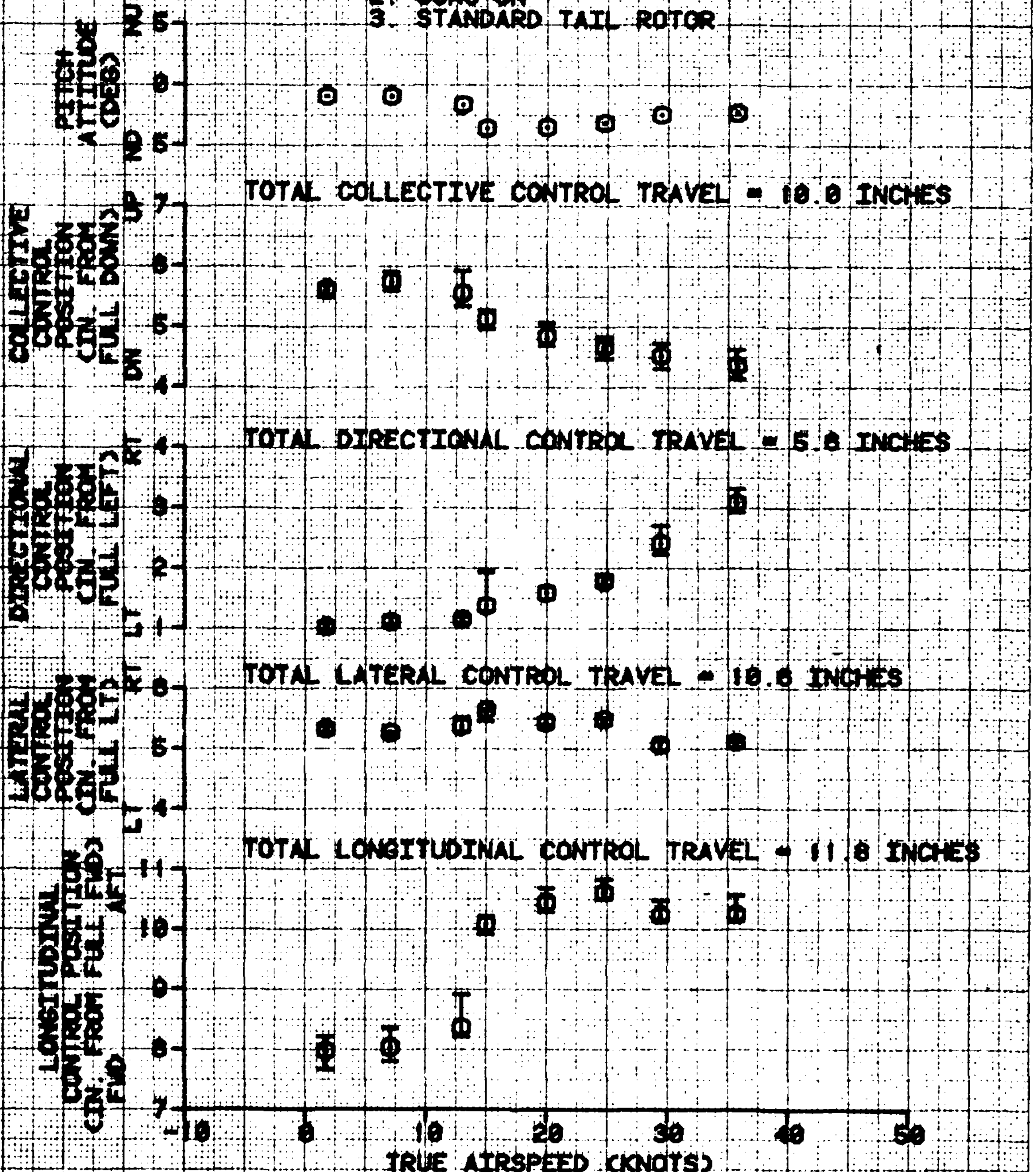


180 DEG. AZIMUTH

FIGURE 74
LOW SPEED FLIGHT 225 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3050	107.2(FWD)	0.4 LT	6000	10.5	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR



225 DEG. AZIMUTH

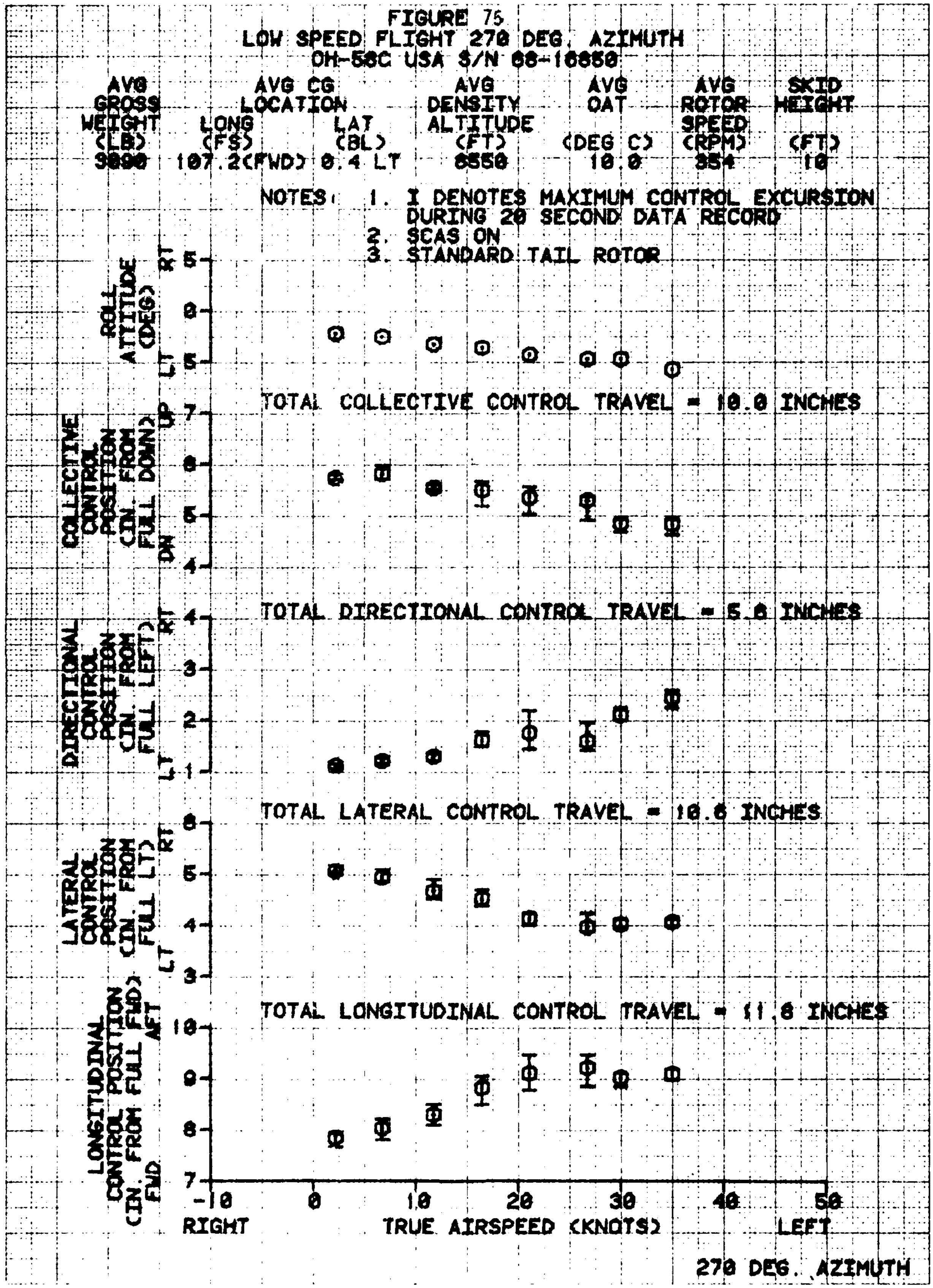
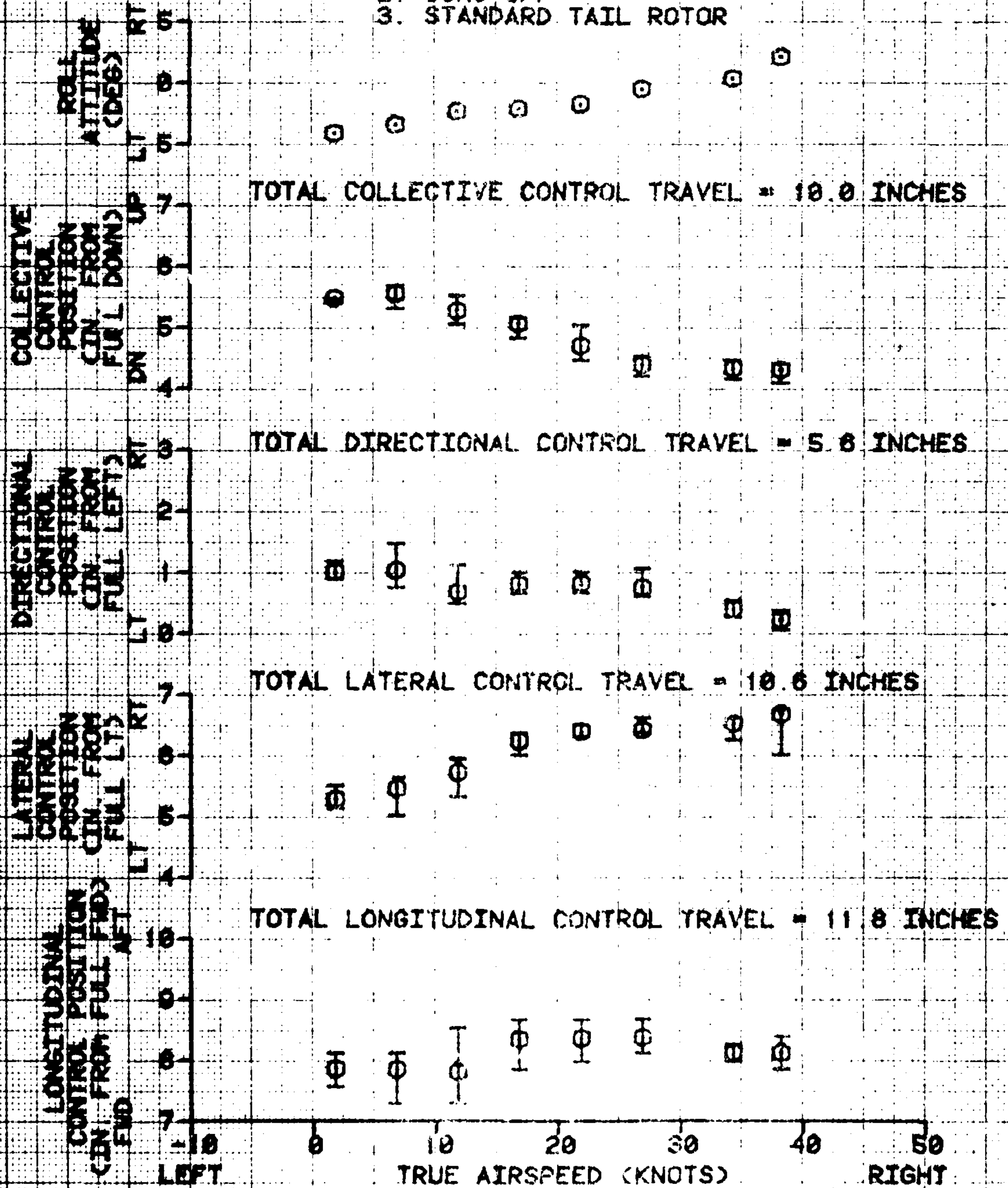


FIGURE 75
LOW SPEED FLIGHT 270 DEG. AZIMUTH
OH-58C USA S/N 68-16850
AVG GROSS WEIGHT (LB) 3090
AVG CG LOCATION LONG (FS) 107.2(FWD) LAT (BL) 0.4 LT
AVG DENSITY ALTITUDE (FT) 6550
AVG OAT (DEG C) 10.0
AVG ROTOR SPEED (RPM) 354
SKID HEIGHT (FT) 10
NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS ON
3. STANDARD TAIL ROTOR
ROLL ATTITUDE (DEG)
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 10.0 INCHES
COLLECTIVE CONTROL POSITION (IN. FROM FULL DOWN)
UP
DN
TOTAL DIRECTIONAL CONTROL TRAVEL = 5.8 INCHES
DIRECTIONAL CONTROL POSITION (IN. FROM FULL LEFT)
TOTAL LATERAL CONTROL TRAVEL = 10.6 INCHES
LATERAL CONTROL POSITION (IN. FROM FULL LT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.8 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
AFT
FWD
RIGHT
TRUE AIRSPEED (KNOTS)
LEFT
270 DEG. AZIMUTH

FIGURE 76
LOW SPEED FLIGHT 90 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3000	107.3(FWD)	0.4 LT	8370	10.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. STANDARD TAIL ROTOR

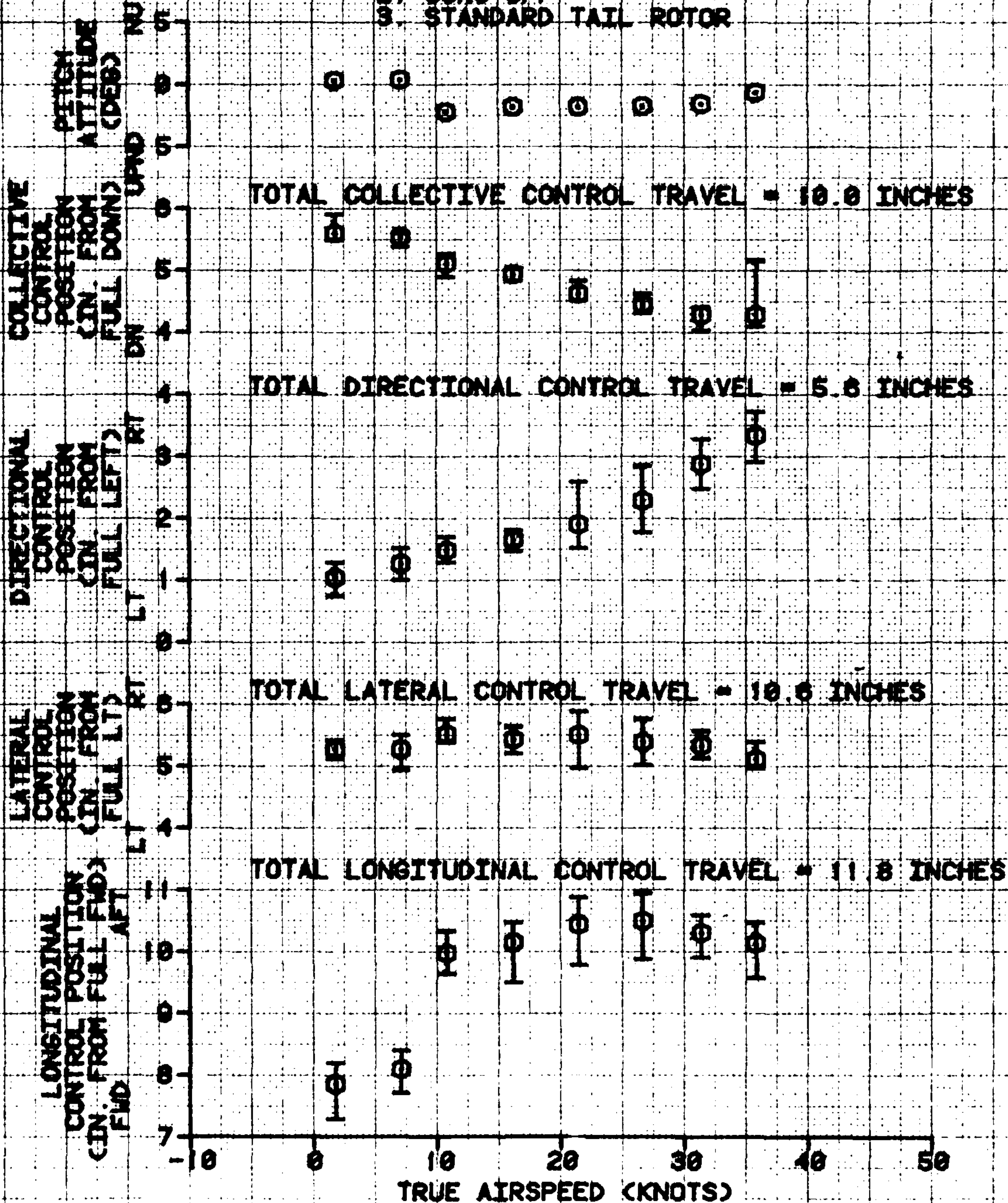


90 DEG. AZIMUTH

FIGURE 78
LOW SPEED FLIGHT 225 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
[illegible]	107.2(FWD)	0.4 LT	6150	8.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. STANDARD TAIL ROTOR



225 DEG. AZIMUTH

FIGURE 79
LOW SPEED FLIGHT 270 DEG. AZIMUTH
OH-58C USA S/N 68-16850

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	SKID HEIGHT (FT)
3100	107.2(FWD)	0.4 LT	7920	6.0	354	10

NOTES: 1. I DENOTES MAXIMUM CONTROL EXCURSION DURING 20 SECOND DATA RECORD
2. SCAS OFF
3. STANDARD TAIL ROTOR

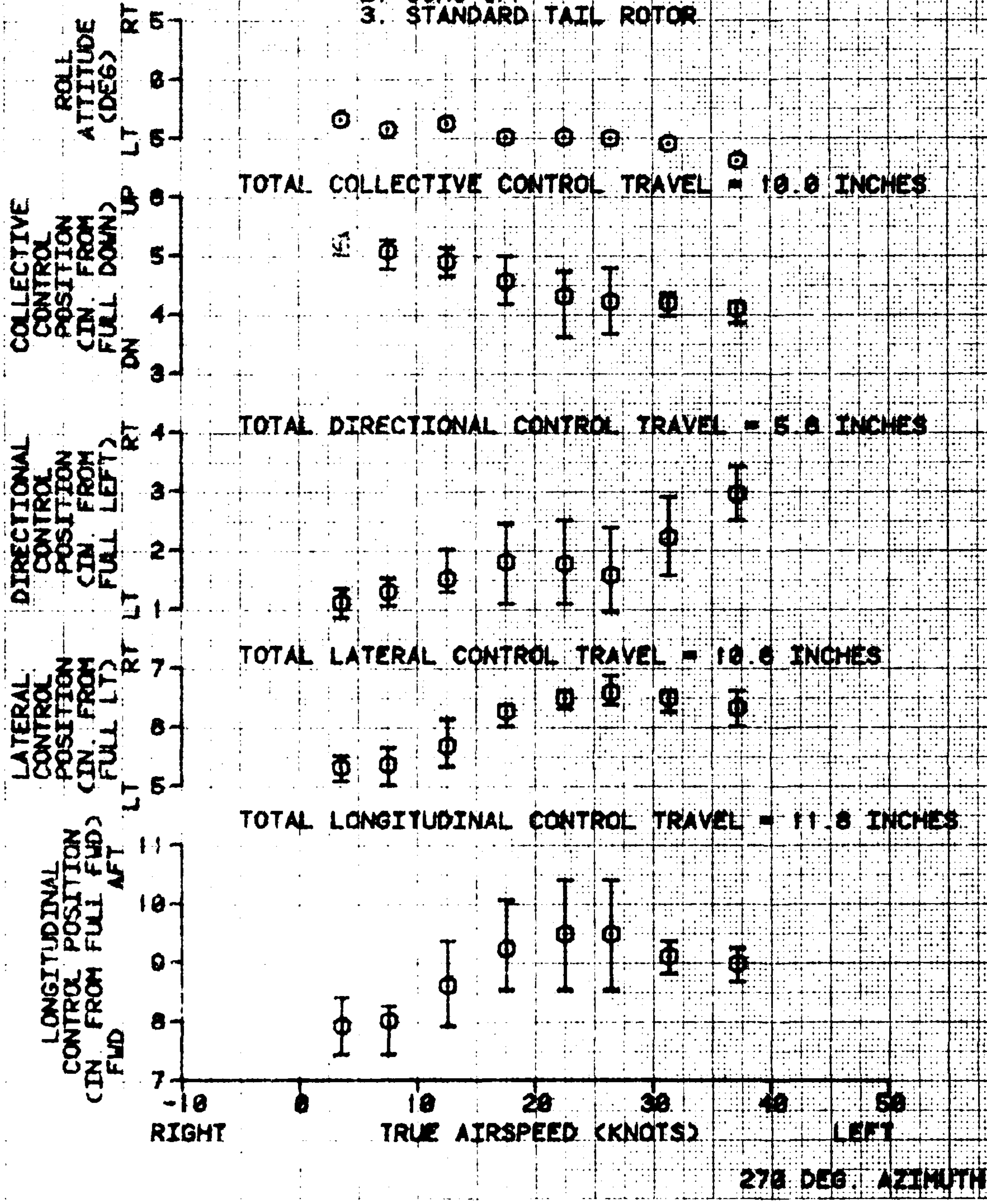


FIGURE 80
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2960	111.8 (AFT)	0.3 RT	4200	20.5	354	60	335 SHP CLIMB

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR

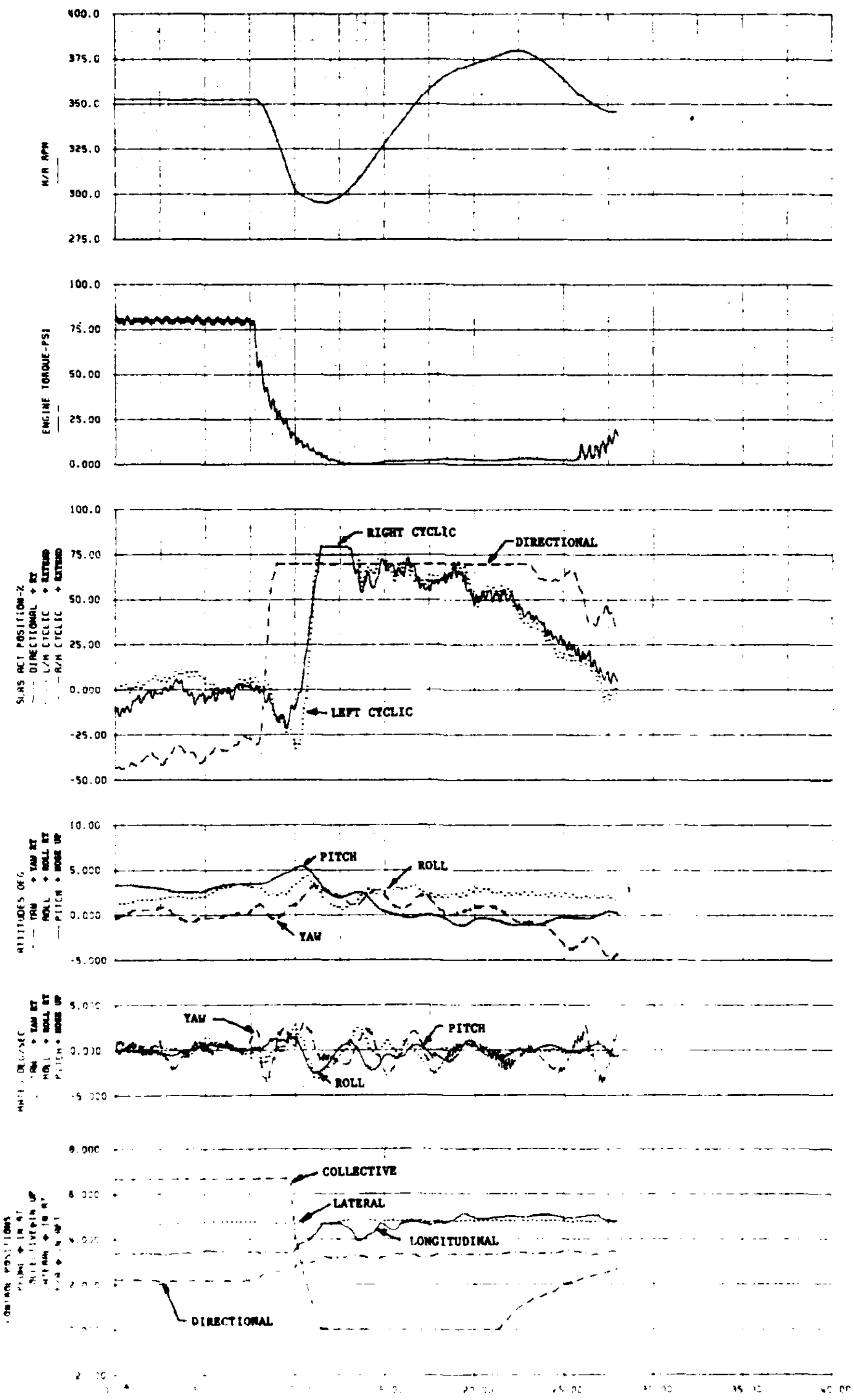


FIGURE 81
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3000	111.8 (AFT)	0.3 RT	4200	20.5	354	90	335 SHP CLIMB

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR

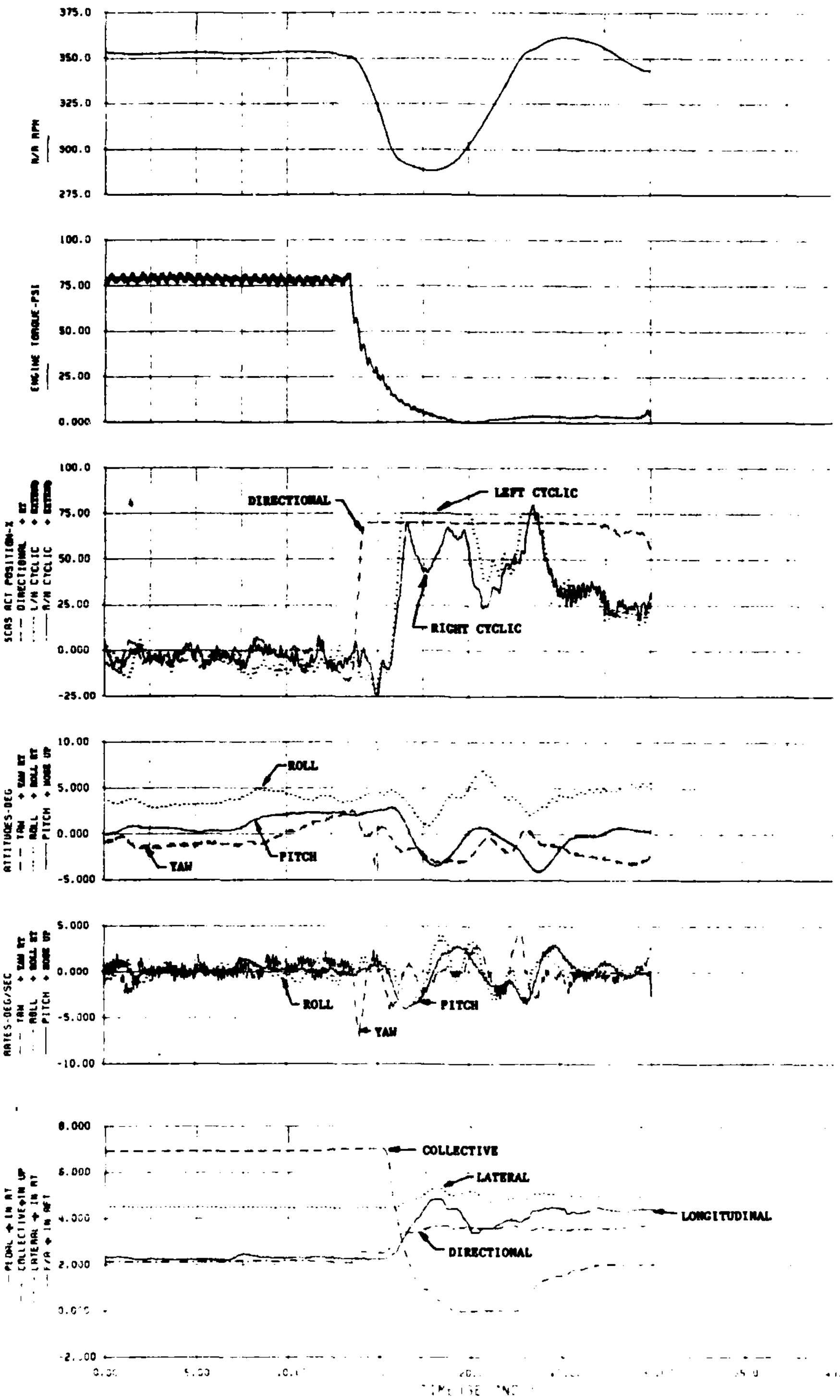


FIGURE 82
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2950	111.8 (AFT)	0.3 RT	4200	20.5	354	115	V_{NE} DIVE

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR

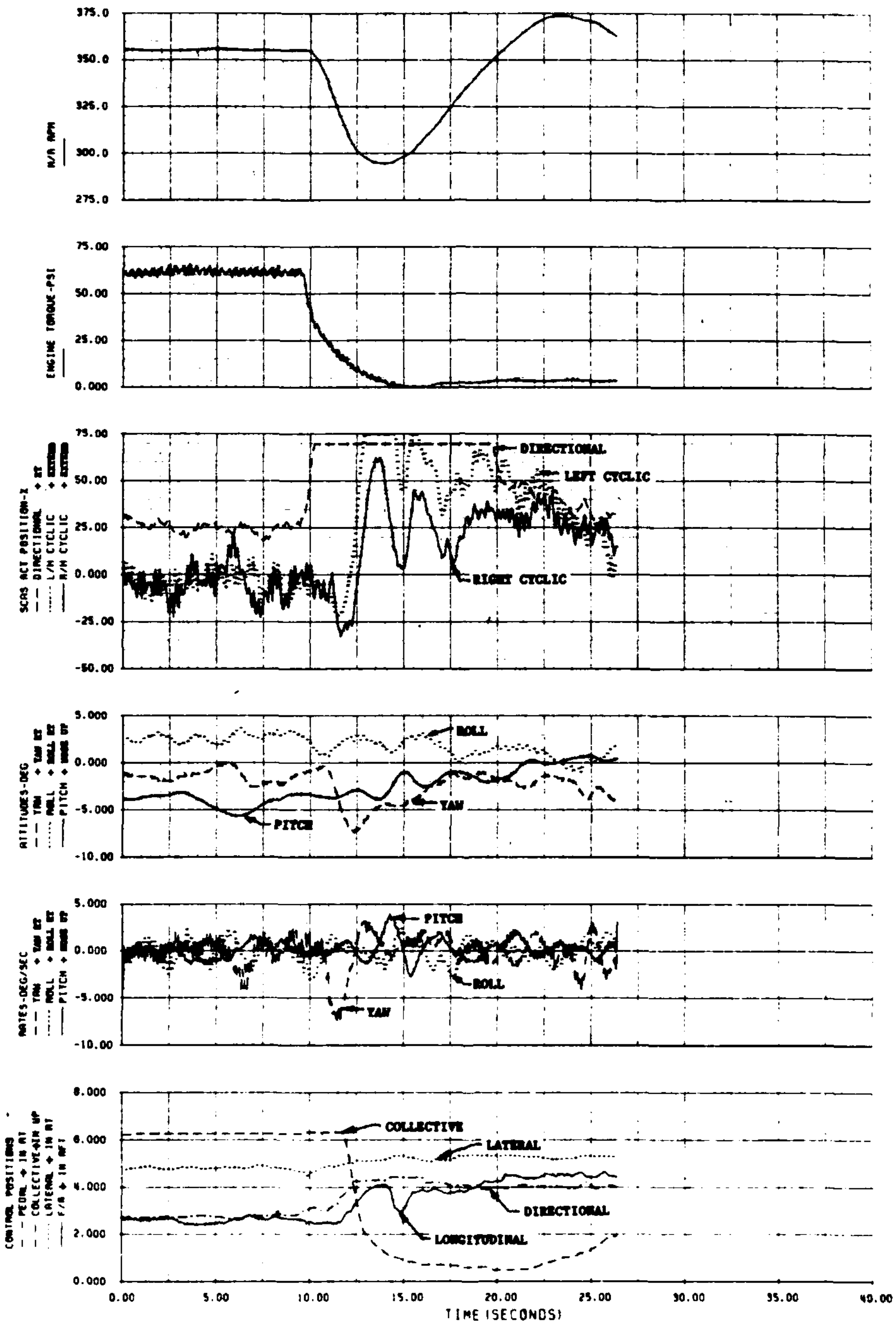


FIGURE 83
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2960	112.2 (AFT)	0.3 RT	5400	24.0	354	61	335 SHP CLIMB

NOTES: 1. SCAS OFF
2. IMPROVED TAIL ROTOR

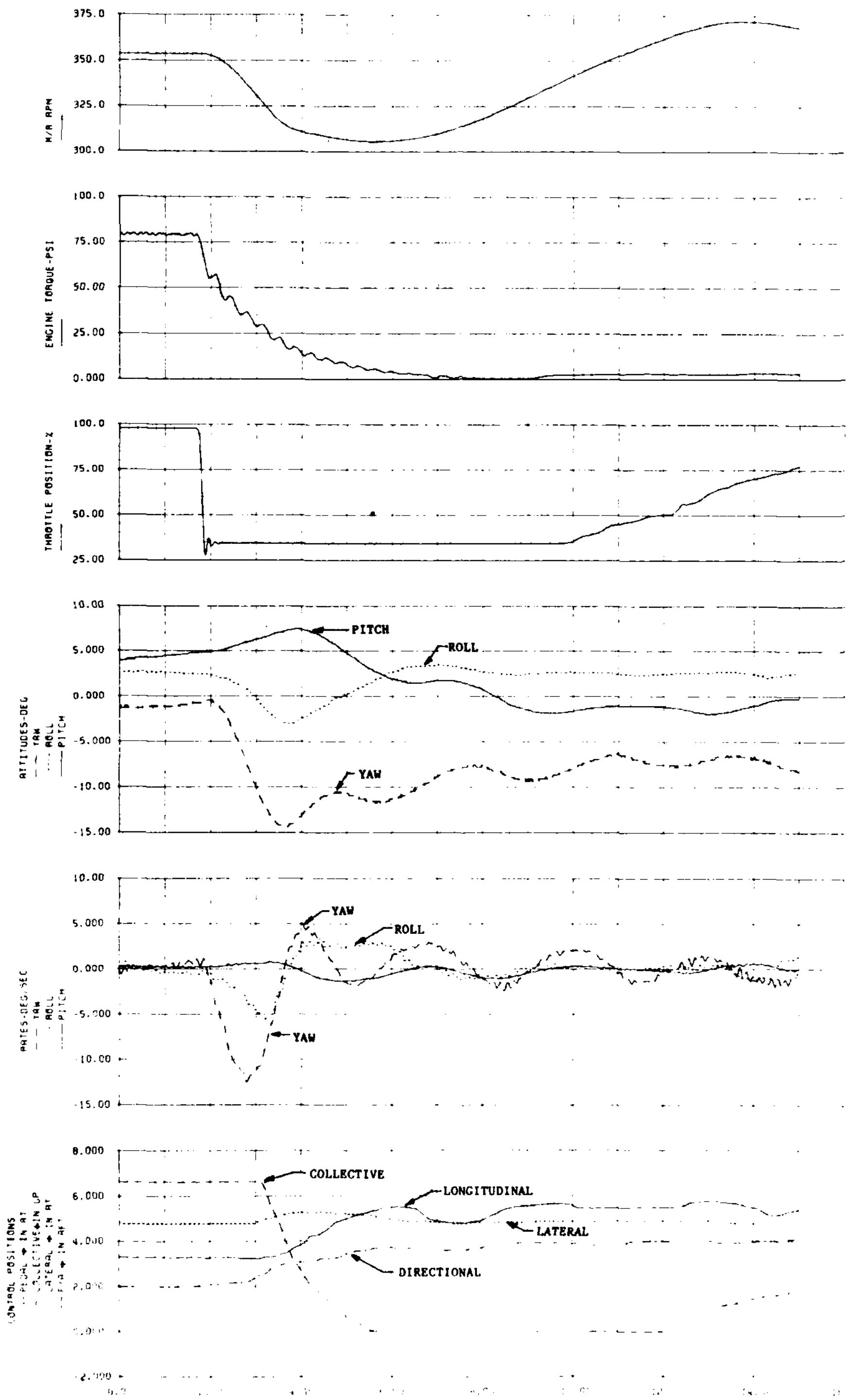


FIGURE 84
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2940	112.3 (AFT)	0.3 RT	5000	25.0	354	90	335 SHP CLIMB

NOTES: 1. SCAS OFF
2. IMPROVED TAIL ROTOR

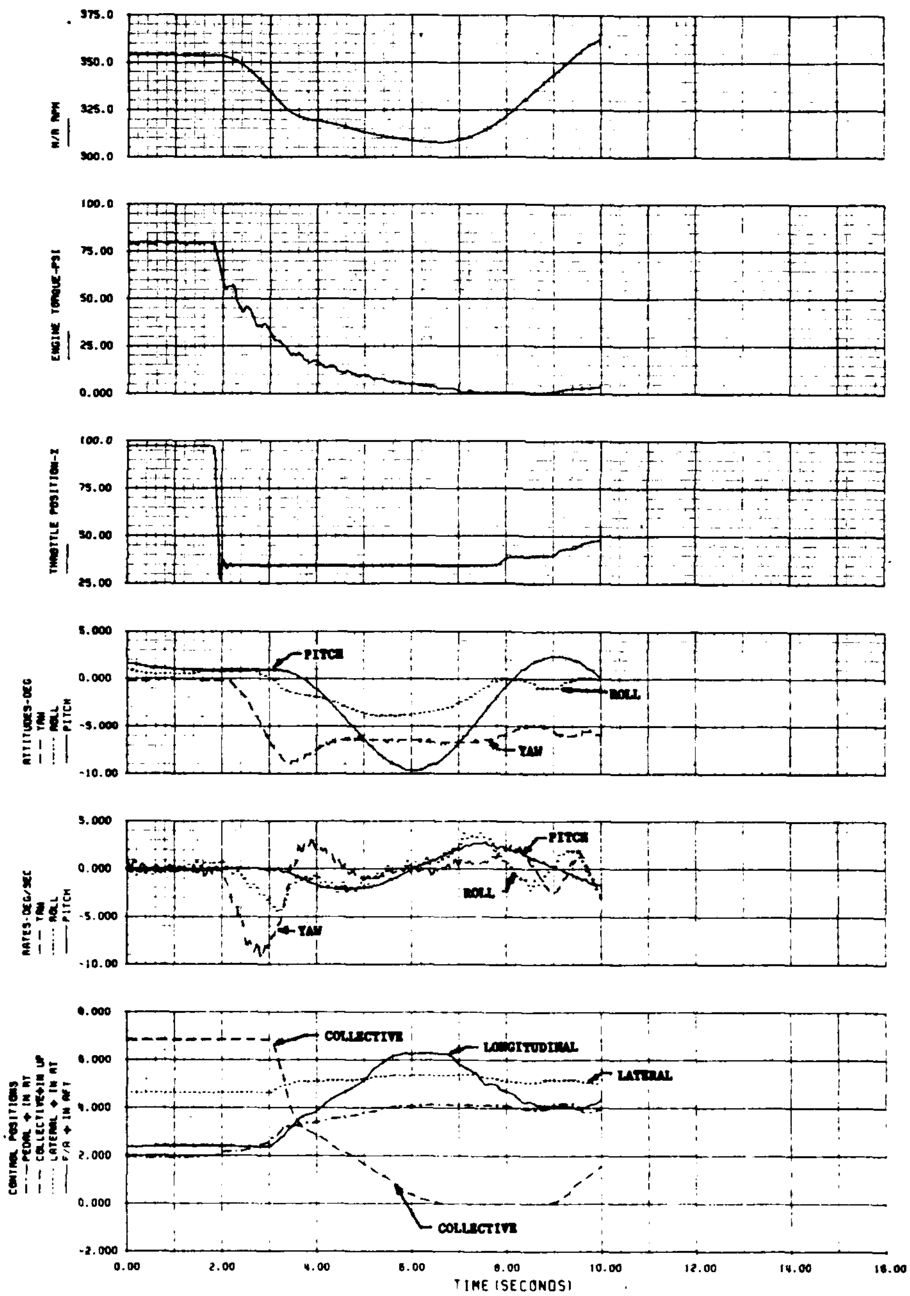


FIGURE 85
SIMULATED SUDDEN ENGINE FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2940	112.3 (AFT)	0.3 RT	5000	25.0	354	V_{NE}	V_{NE} DIVE

NOTES: 1. SCAS OFF
2. IMPROVED TAIL ROTOR

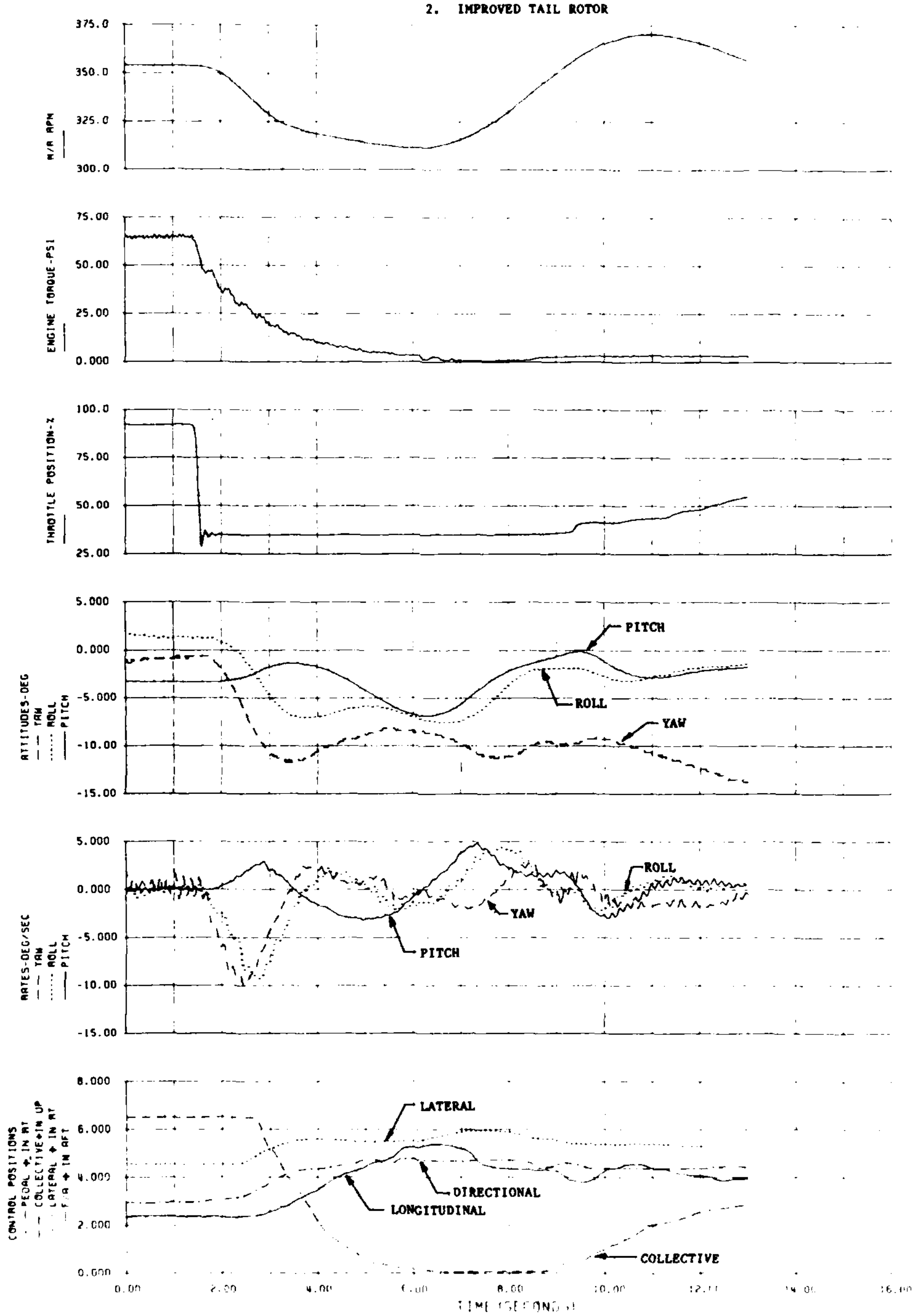


FIGURE 86
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3000	111.8 (AFT)	0.3 RT	5100	32.0	354	90	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. RIGHT CYCLIC ACTUATOR RETRACT HARDOVER

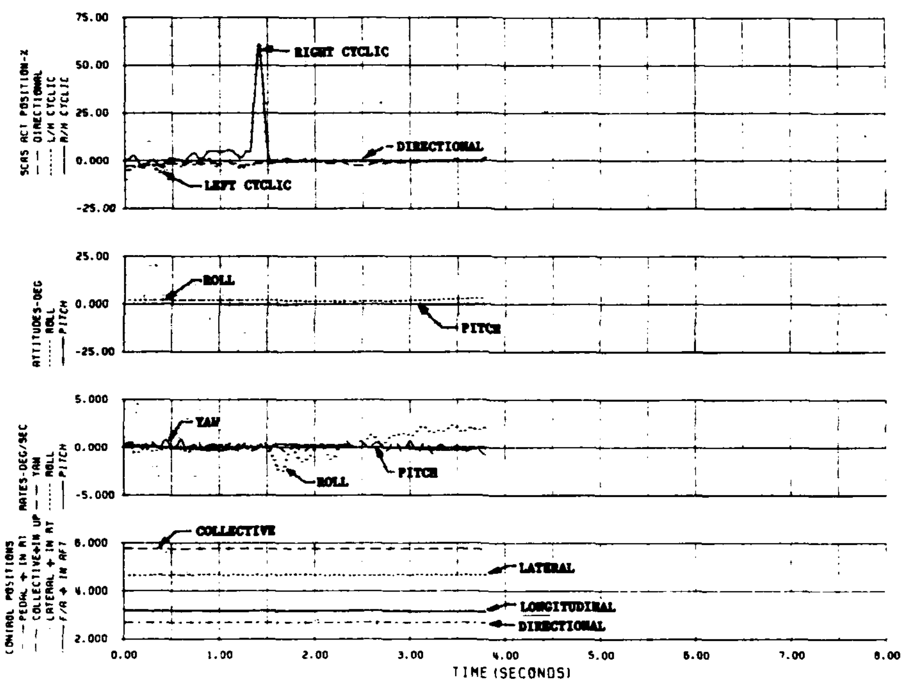


FIGURE 87
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
3000	111.8 (AFT)	0.3 RT	5100	32.0	354	90	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. RIGHT CYCLIC ACTUATOR EXTEND HARDOVER

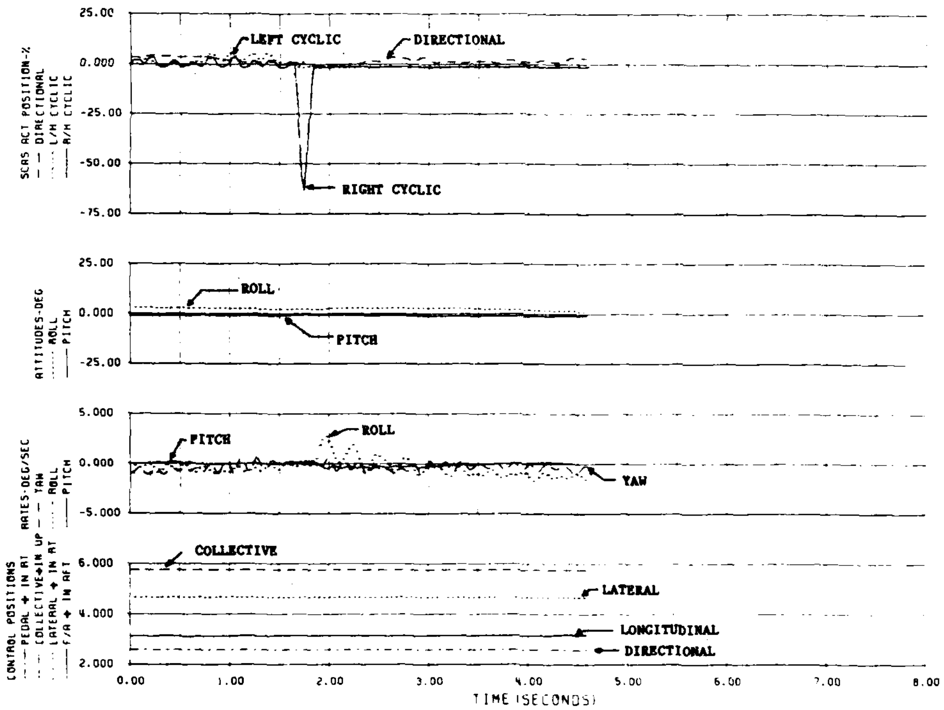


FIGURE 88
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2980	111.8 (AFT)	0.3 RT	5200	31.0	354	90	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. RIGHT DIRECTIONAL ACTUATOR HARDOVER

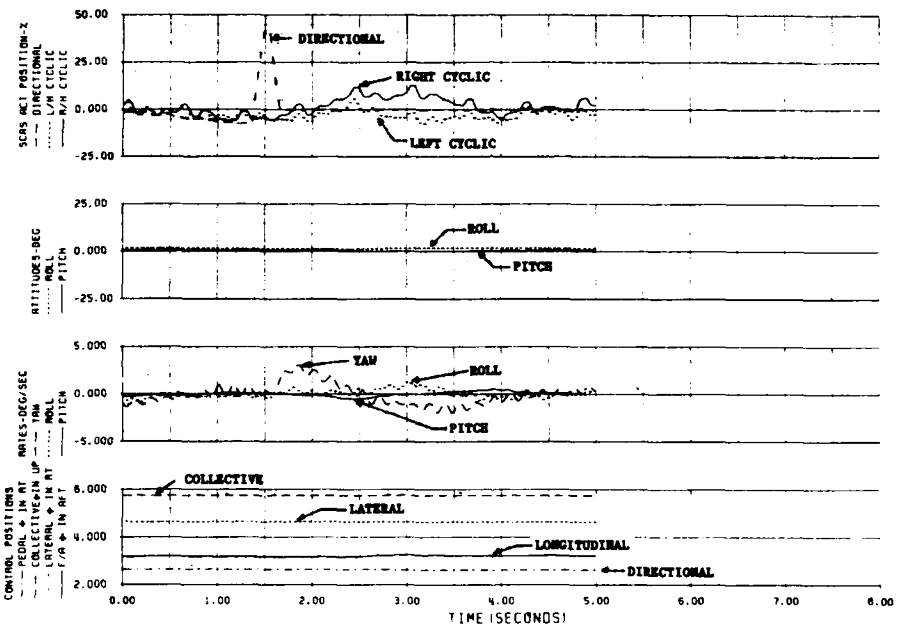


FIGURE 89
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2980	111.8 (AFT)	0.3 RT	5200	31.0	354	90	LEVEL

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. LEFT DIRECTIONAL ACTUATOR HARDOVER

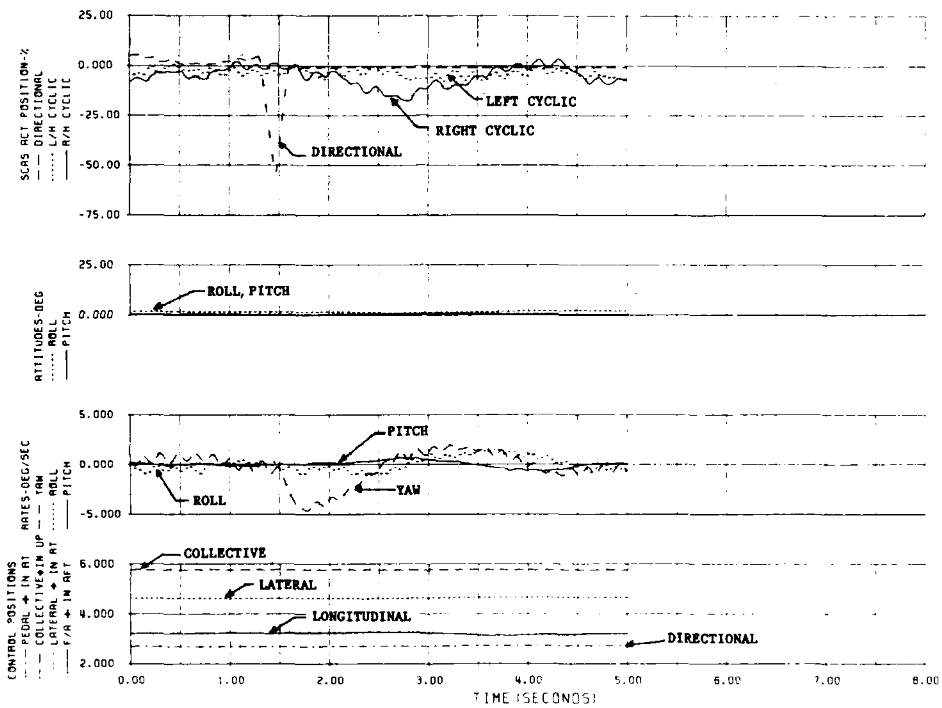


FIGURE 90
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2940	111.9 (AFT)	0.3 RT	5100	31.0	354	90	LEVEL TURN

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. LEFT CYCLIC ACTUATOR RETRACT HARDOVER

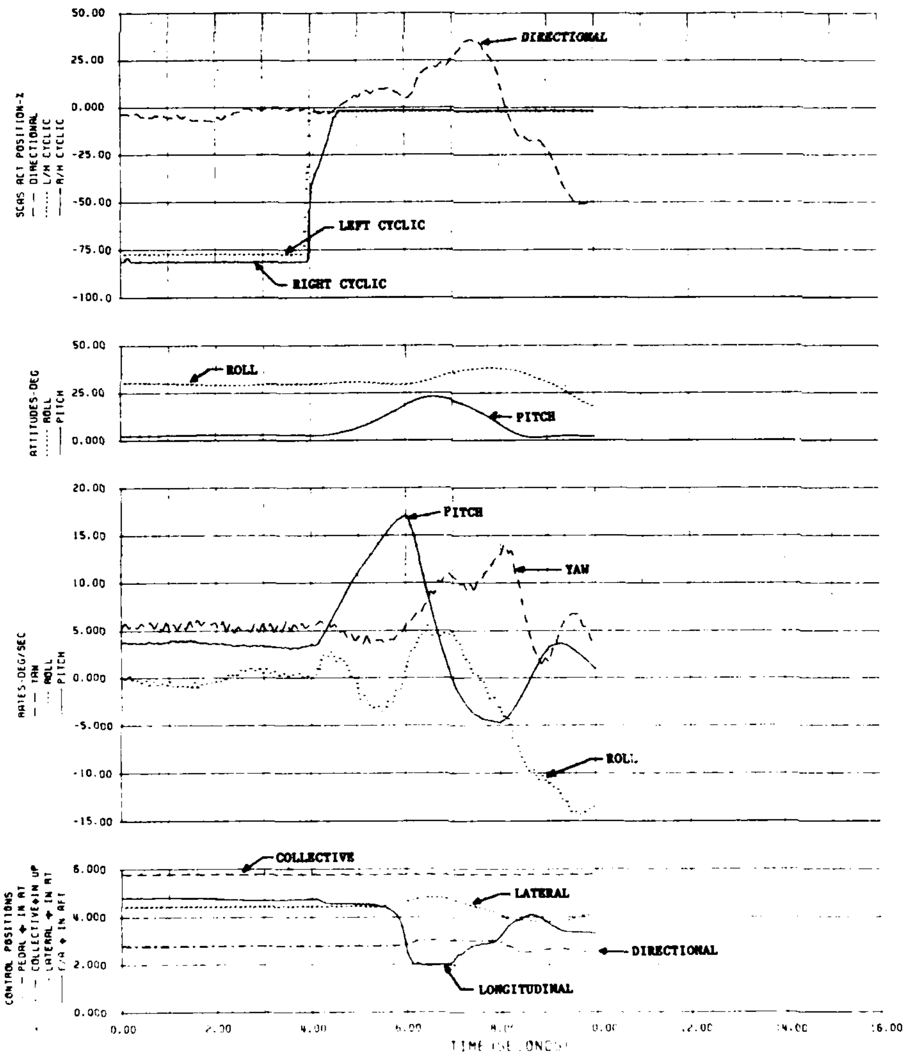


FIGURE 92
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2980	111.8 (AFT)	0.3 RT	4800	21.0	354	V_{NE}	DIVING TURN

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. LEFT CYCLIC ACTUATOR RETRACT HARDOVER

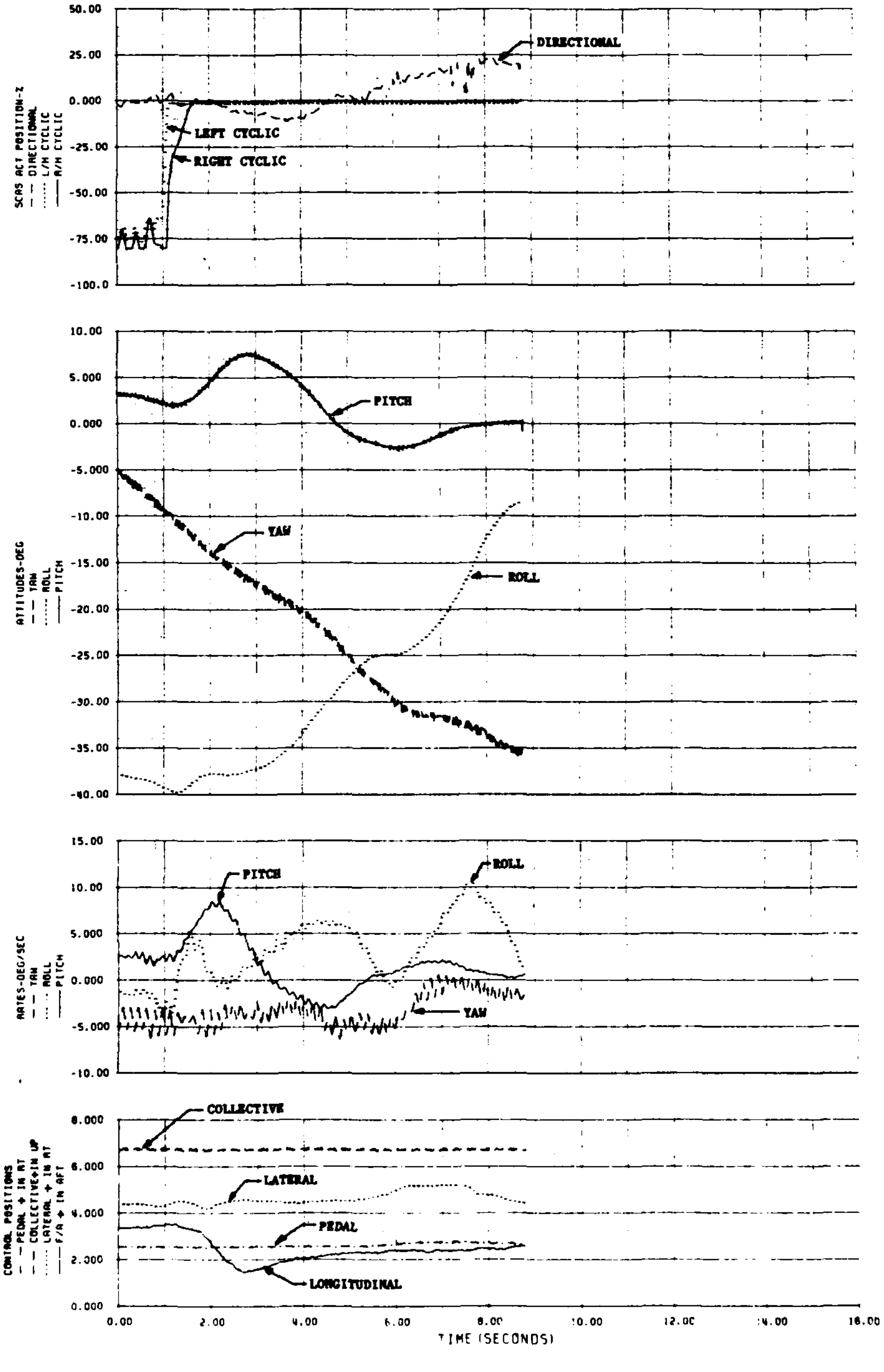


FIGURE 93
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2880	112.5 (AFT)	0.3 RT	5000	21.0	354	115	DIVING TURN

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. RIGHT CYCLIC ACTUATOR RETRACT HARDOVER

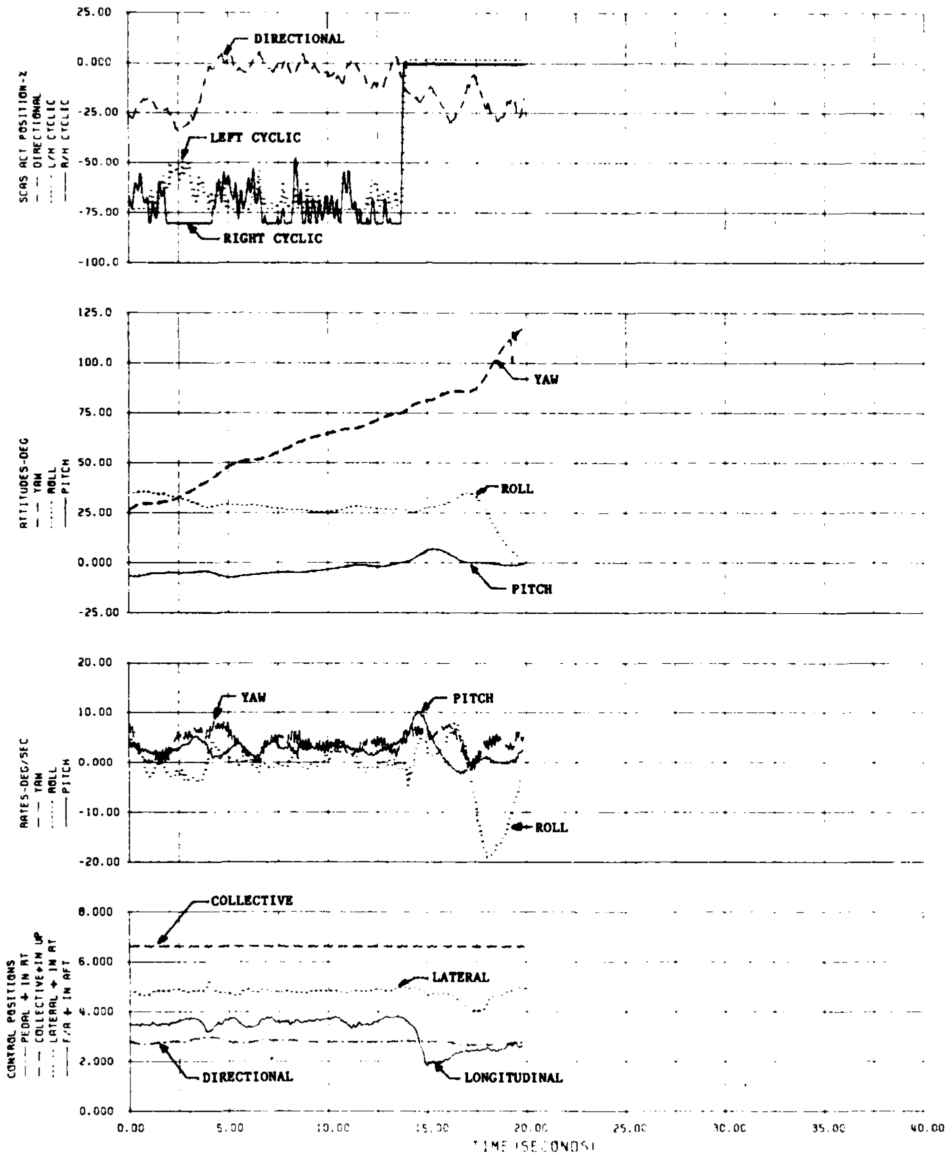


FIGURE 94
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2960	111.8 (AFT)	0.3 RT	5100	31.0	354	90	LEVEL TURN

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. RIGHT CYCLIC ACTUATOR EXTEND HARDOVER

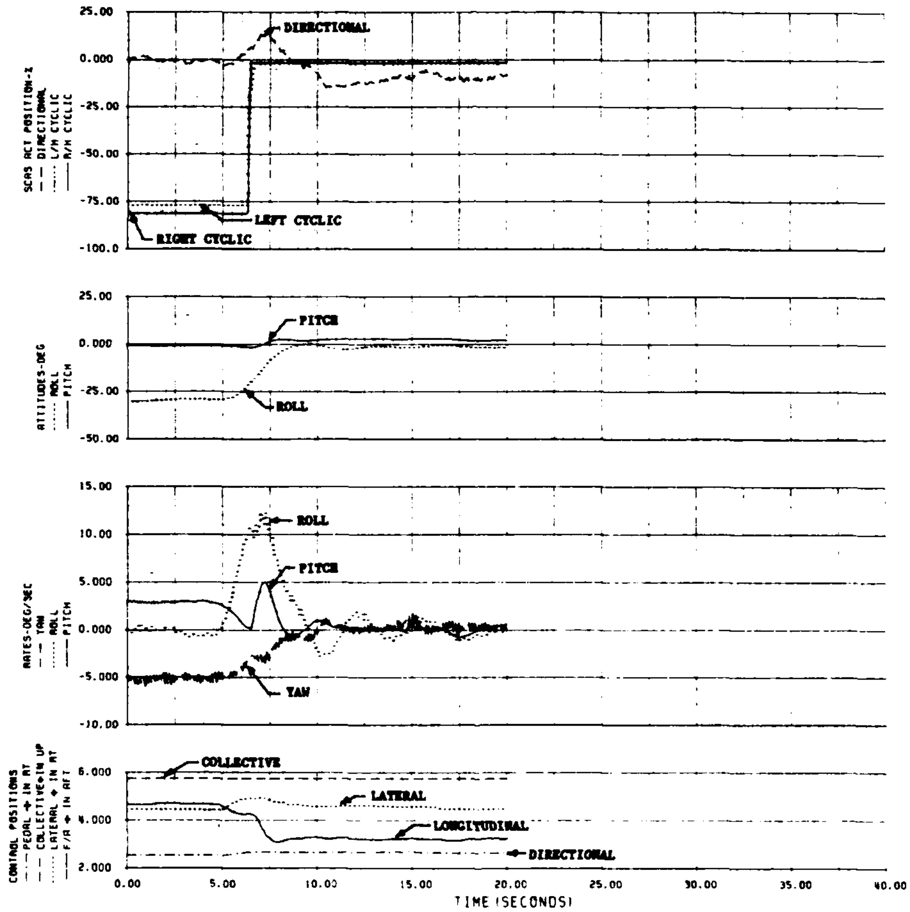


FIGURE 95
SIMULATED SCAS FAILURE
OH-58C USA S/N 68-16850

AVERAGE GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	TRIM DENSITY ALTITUDE (FT)	AVG OAT (°C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KCAS)	TRIM FLIGHT CONDITION
2960	111.8 (AFT)	0.3 RT	5100	31.0	354	90	LEVEL TURN

NOTES: 1. SCAS ON
2. IMPROVED TAIL ROTOR
3. LEFT CYCLIC ACTUATOR EXTEND HARDOVER

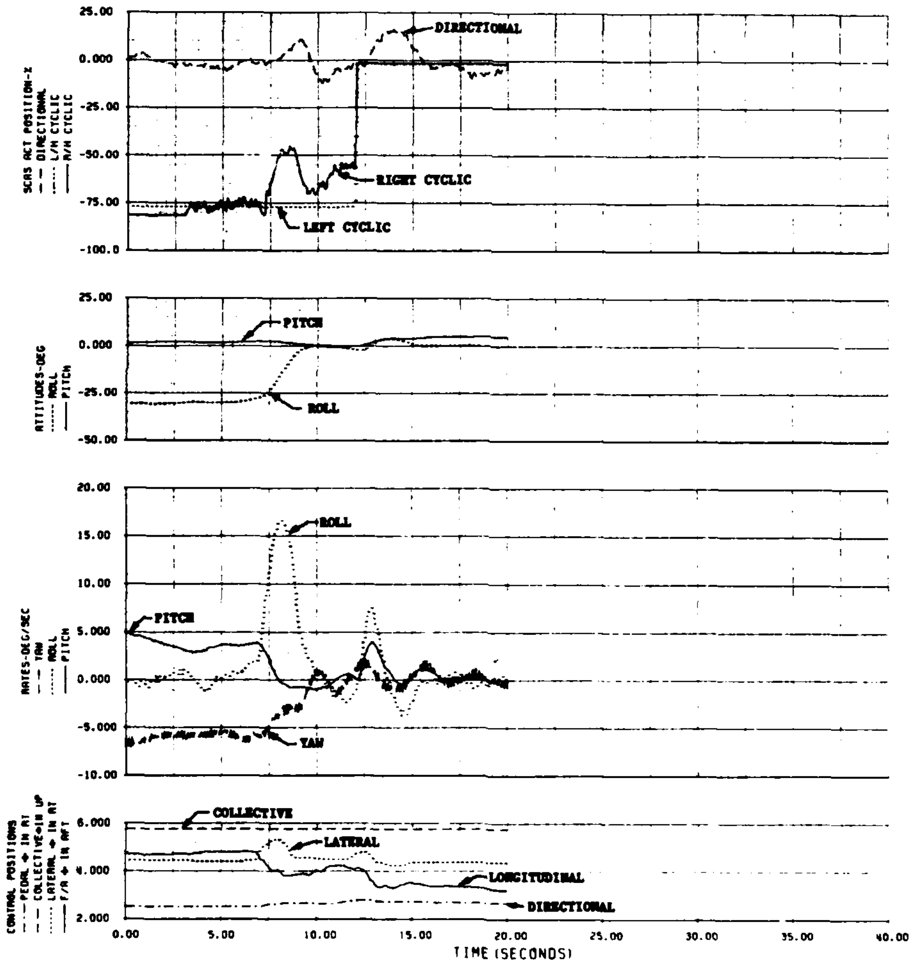


FIGURE 95
VIBRATION CHARACTERISTICS OF PILOT SEAT
OH-58C USA S/N 68-16850

NOTE: ACCELEROMETER LOCATED ON PILOT'S SEAT SUPPORT

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	3200	107.3 (FWD)	0.2 (RT)	6110	17.0	354	CLEAN, DOORS ON	LEVEL
⊡	3160	111.3 (AFT)	0.1 (RT)	5050	24.5	354	CLEAN, DOORS ON	LEVEL
△	3000	111.8 (AFT)	0.4 (RT)	4960	24.5	353	CLEAN, DOORS ON	LEVEL

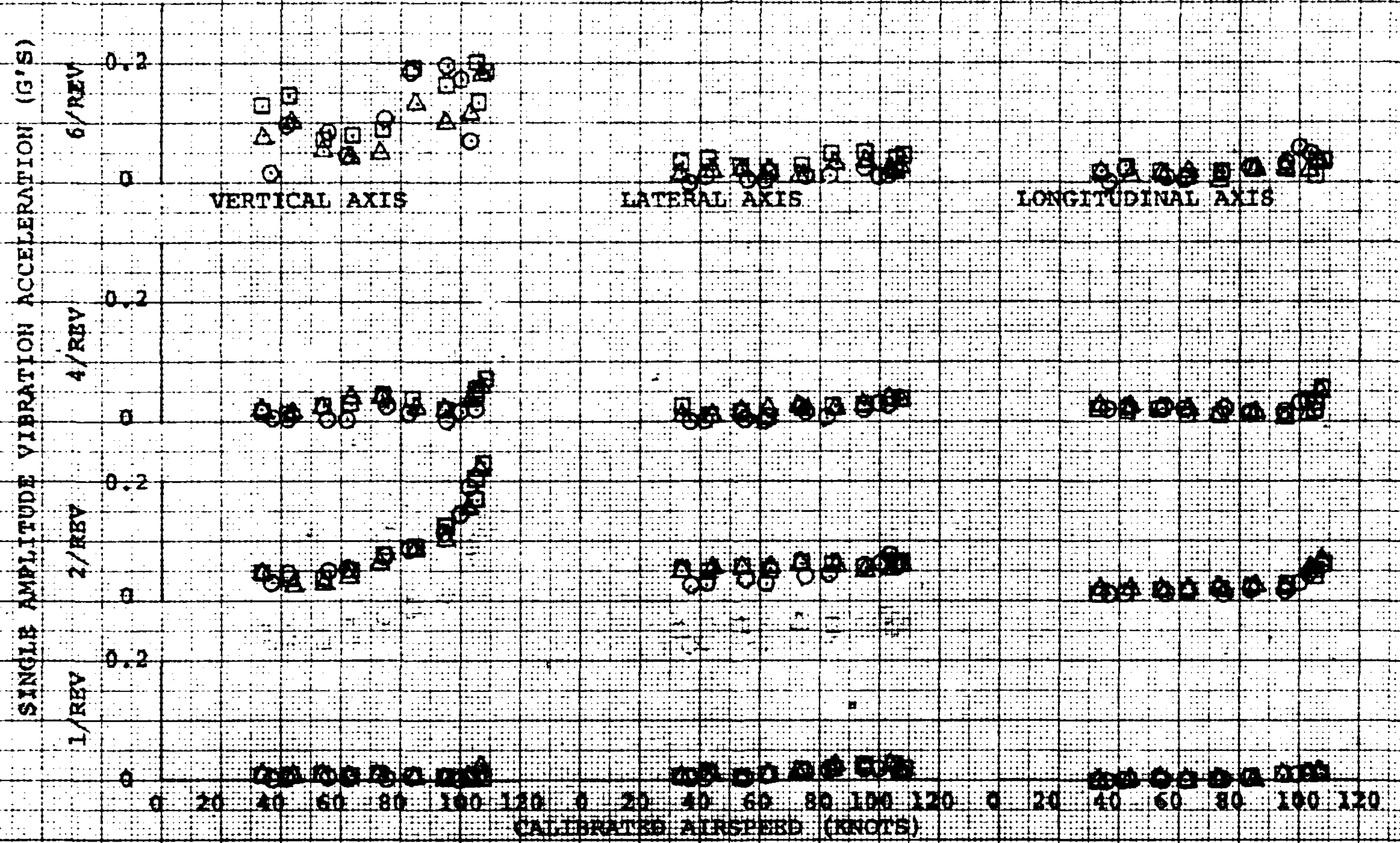


FIGURE 97
VIBRATION CHARACTERISTICS OF COPILOT SEAT
OH-58C USA S/N 68-16850
NOTE: ACCELEROMETER LOCATED ON COPILOT'S SEAT SUPPORT

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	AVG. C.G. LOCATION LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
○	3200	107.3 (FWD)	0.2 (RT)	6110	17.0	354	CLEAN, DOORS ON	LEVEL
□	3160	111.3 (AFT)	0.1 (RT)	5050	24.5	354	CLEAN, DOORS ON	LEVEL
△	3000	111.8 (AFT)	0.4 (RT)	4960	24.5	353	CLEAN, DOORS ON	LEVEL

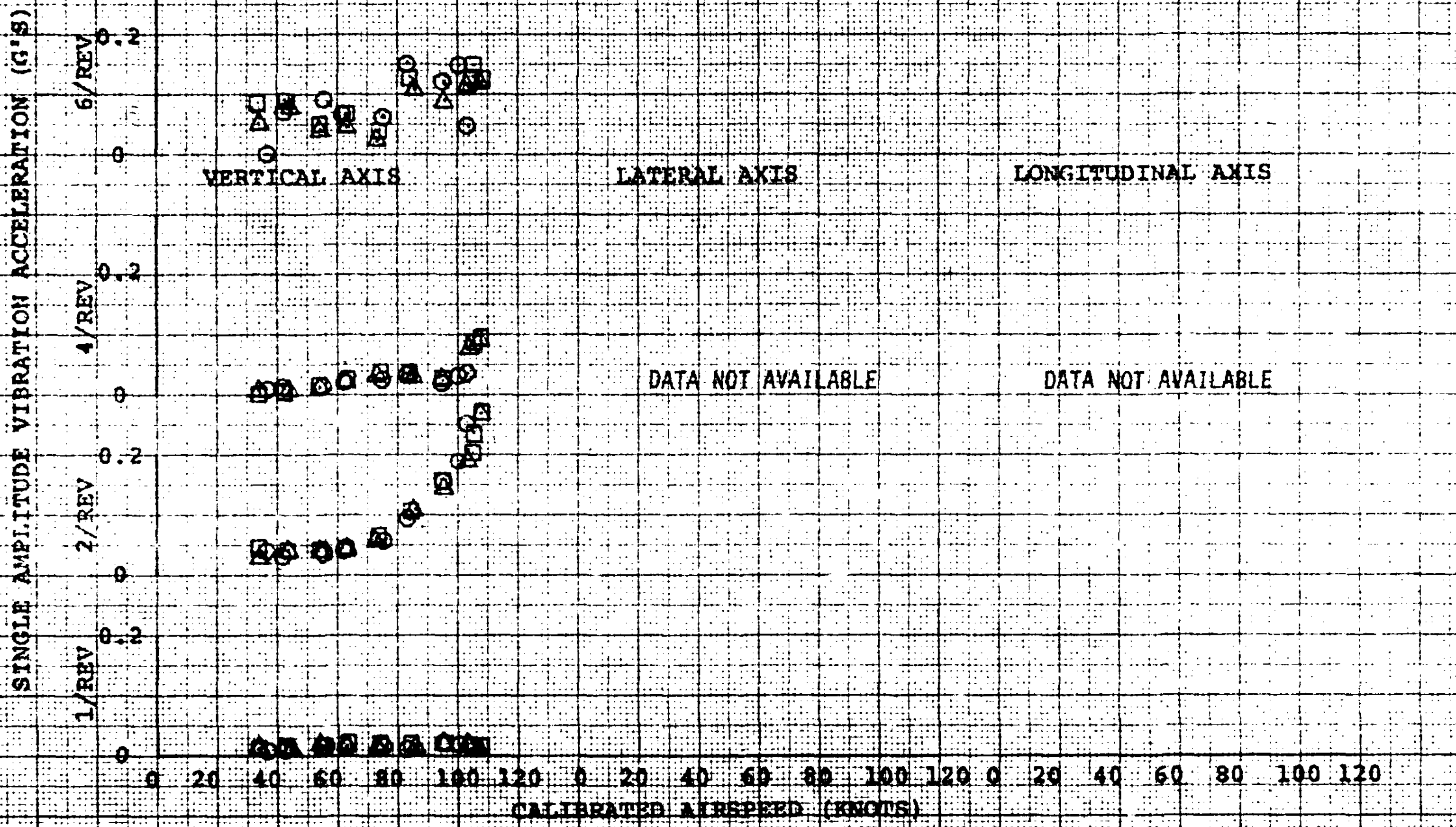


FIGURE 98

VIBRATION CHARACTERISTICS OF THE CENTER OF GRAVITY
OH-58C USA S/N 68-16850

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	AVG. C.G. LOCATION LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	3200	107.3(FWD)	0.2(RT)	6110	17.0	354	CLEAN, DOORS ON	LEVEL
⊡	3160	111.3(AFT)	0.1(RT)	5050	24.5	354	CLEAN, DOORS ON	LEVEL
△	3000	111.8(AFT)	0.4(RT)	4960	24.5	353	CLEAN, DOORS ON	LEVEL

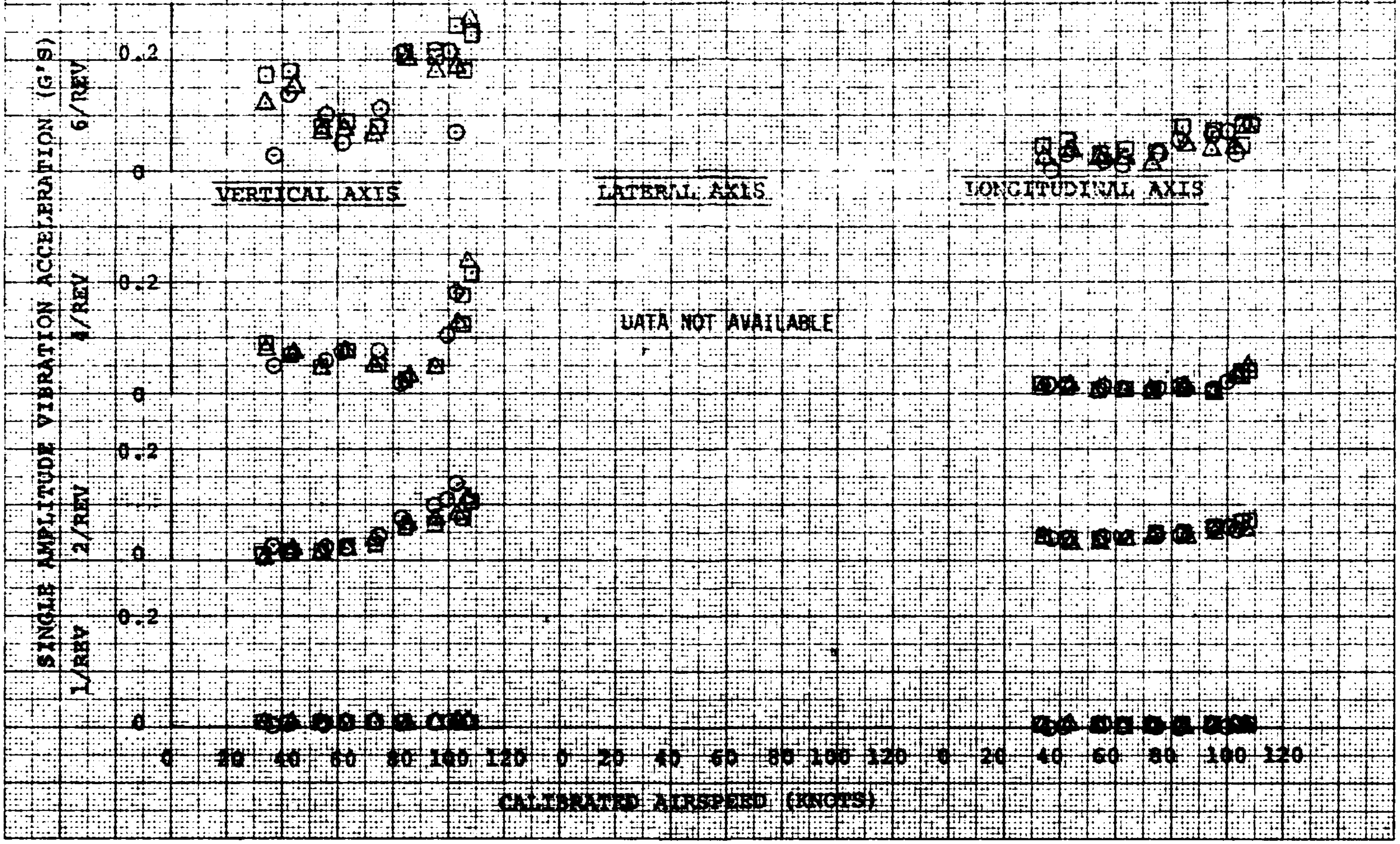


FIGURE 49
VIBRATION CHARACTERISTICS OF PILOT SEAT
OH-58C USA S/N 68-16850

NOTE: ACCELEROMETER LOCATED ON PILOT'S SEAT SUPPORT

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	AVG. C.G. LOCATION LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
○	3160	111.0 (AFT)	0.1 (RT)	5020	25.0	[illegible]	CLEAN, DOORS ON	335 SHP CLIMB

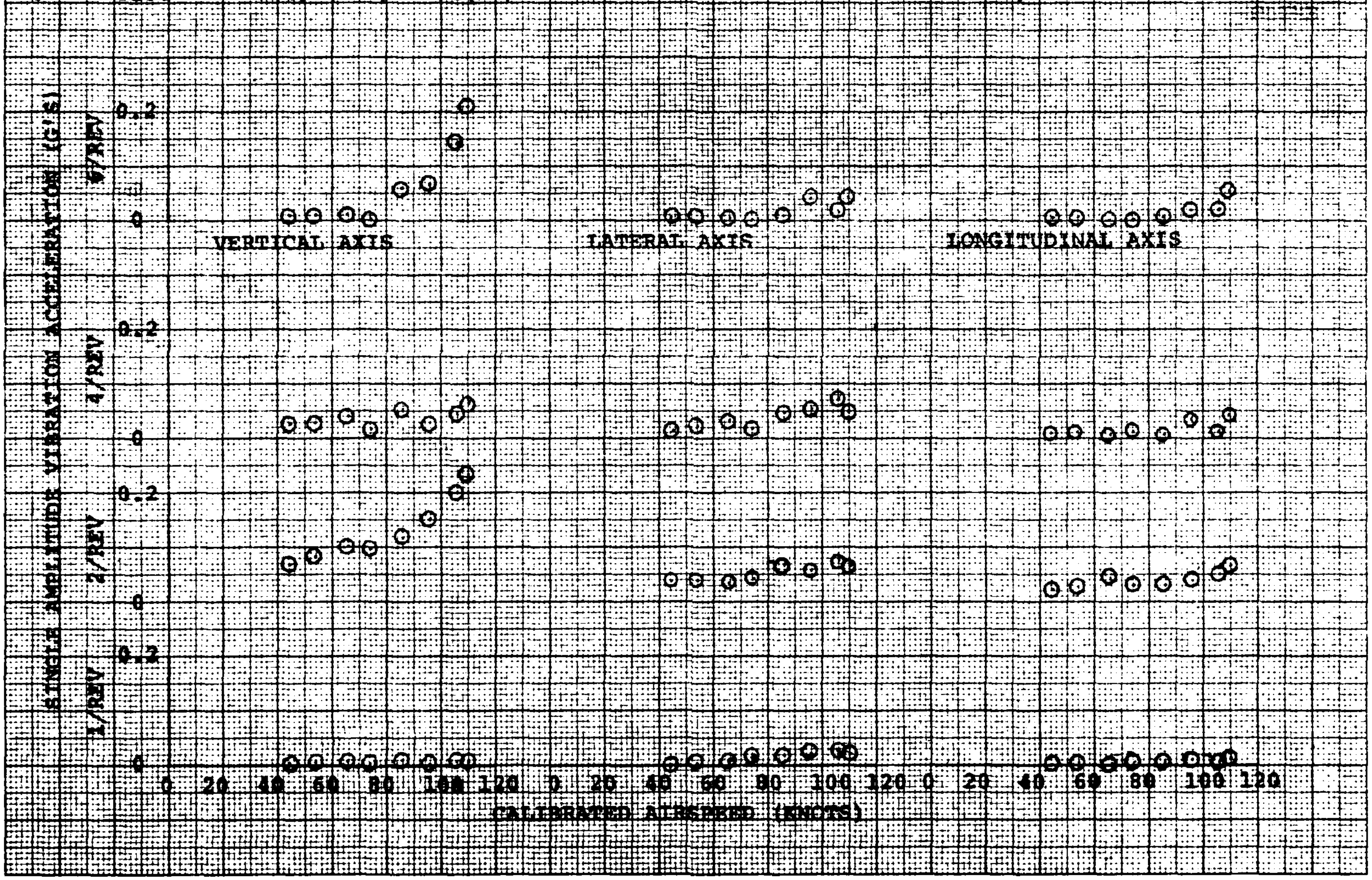


FIGURE 100
VIBRATION CHARACTERISTICS OF COPILOT SEAT
NOTE: ACCELEROMETER LOCATED ON COPILOT'S SEAT SUPPORT

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	AVG. C.G. LOCATION LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	CONDITION
⊙	3160	111.0(AFT)	0.1(RT)	5020	25.0	352	CLEAN, DOORS ON	335 SHP CLIMB

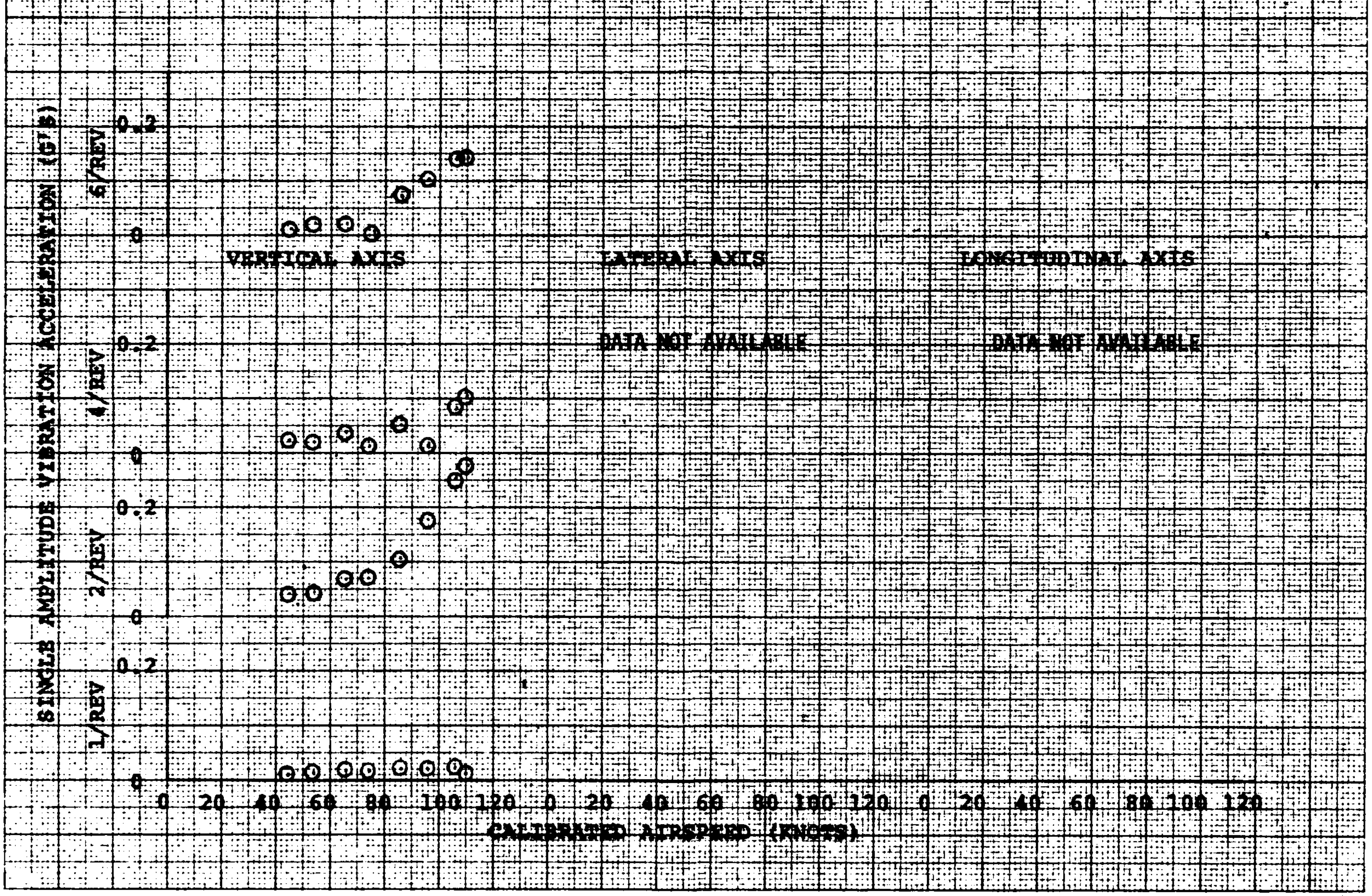
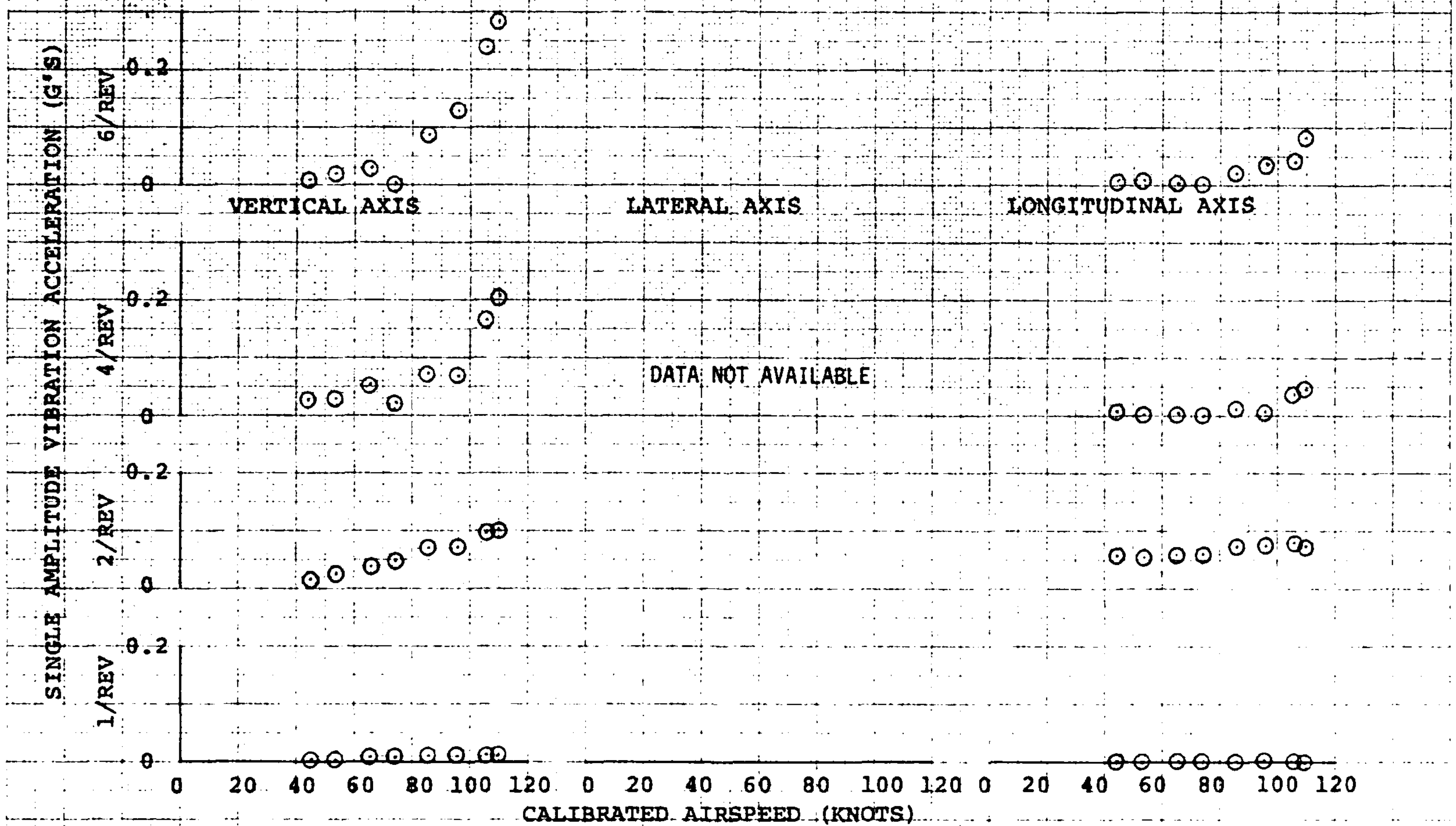


FIGURE 101
VIBRATION CHARACTERISTICS OF THE CENTER OF GRAVITY
OH-58C USA S/N 68-16850

SYM	AVG. GROSS WEIGHT (LB)	AVG. C.G. LOCATION LONG. (IN)	AVG. C.G. LOCATION LAT. (IN)	AVG. DENSITY ALTITUDE (FT)	AVG. OAT (°C)	ROTOR SPEED (RPM)	CONFIGURATION	FLIGHT CONDITION
⊙	3160	111.0 (AFT)	0.1 (RT)	5020	25.0	352	CLEAN, DOORS ON	335 SHP CLIMB



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